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Editorial

Dr. Eligar Sadeh

Dr. Sadeh is Associate Director of the Eisenhower Center for Space and Defense Studies

There is a strong case to be made that space is in the national security interest, but a much weaker case is to be made that space is in the national economic interest. In the United States (U.S.), national security tends to trump commercial space concerns leading to policies and laws, like in the area of export control, that undermine space commercial development.

This special issue of *Space and Defense* is focused on the current approach to export control of commercial space technologies, namely the International Traffic in Arms Regulations (ITAR). Simply put, ITAR is obtrusive, broken, and obsolete. ITAR has prevented international partnerships in commercial space, or made them exceedingly more difficult and bureaucratic to implement. It has dramatically reduced U.S. domestic manufacturing capabilities for vital space-related hardware and components.

The great irony is that ITAR, in stark contrast to its intended goal of retaining domestic preeminence for the U.S. in the aerospace and defense fields, is having exactly the opposite effect. America's leadership in commercial space capabilities has eroded, while Russian, European, and Asian entities have expanded and deepened their growing dominance. The U.S. has fallen behind in the global space commerce competition due in no small part to its counterproductive export control regime.

ITAR is not only harmful to commercial space, but it also damages national security by placing legal and bureaucratic restrictions on the U.S. military use of commercial space assets that rely on a robust satellite industry and space industrial base. ITAR has led to the problem that "we are denying our allies access to space protection capabilities" significantly impacting how the U.S. deals with national security space issues.

There is a need to address this export control issue at the level of policy by reforming the "rule set" for how ITAR is applied. The current Presidential Directive on export control reform is a start. The Directive calls for reducing the export licensing time to no more than sixty days, and for streamlining the process on how a technology is looked at in regard to the ITAR Munitions Control List (MCL). More congressional funding is needed to push through the ITAR reforms suggested by the Presidential Directive on ITAR. The new Directive is a good step to help fix the competitiveness and licensing problems associated with ITAR.

Further ITAR reforms are needed. This encompasses a reassessment of what technologies need to be controlled, and dealing with issues of timing, review processes, transparency, and cost. Congress needs to take on the issue by updating export control laws to better match 21st Century global space commerce. This starts with reforming the current approach to ITAR by moving jurisdiction on all dual-use commercial space technologies from the Department of State to the Department of Commerce, to legislating new export control laws that update and replace the antiquated "Cold War" legislation that is still in place, e.g., Arms Export Control Act and Export Administration Act.

The articles and documents published in this special issue of *Space and Defense* address many of the issues highlighted above. This includes the historical development of the U.S. export control regime within the context to address Cold War foreign policy concerns, how ITAR is implemented today, and finally, what are the problems with ITAR implementation and how can those problems be addressed through policy and law.

Space and Defense, Winter 2008

The History of United States Weapons Export Control Policy

Taylor Dinerman

Author and Journalist, New York City

All nations regulate Arms sales, but the United States (U.S.) has traditionally gone further than most. After World War I, a conspiracy theory made its way into popular culture that blamed the war, and specifically the U.S. intervention in 1917, on the so called "merchants of death." Ever since, this has been a powerful and enduring theme in politics and culture throughout the world. Yet, nowhere have the effects of this theory been more enduring than in U.S. policy and law.

At the time, arms sales were seen by European governments as tools of statecraft. Referring to the efforts by Britain and France to sell ships to the Baltic states, one recent study explained:

> ...winning the orders became important to the economic health of both nations, but they also believed other benefits fell to the power winning the bids. To the British and the French navies, selling warships became a means of propping up their respective naval industries. To the British and French governments, and their naval leaders, sales meant influence. And influence meant control. And control meant more orders. But this assumption proved as wrong as much of British and French thinking between the wars.[1]

In contrast, the U.S. refused to sell ships and submarines to these small states both because of a policy of not wanting to sell ships at all and due to a fear that they "…might eventually fall into the hands of the Bolsheviks."[2] As long as the U.S. stayed more or less isolated from world power politics, its decision on whether or not to export weapons or technology mattered little, except to the foreign states involved and to the U.S. firms that were affected. During the interwar period, when U.S. technology slowly began to overtake that of Europe, especially in the aeronautical field, these decisions became more significant.

Before World War II, export restrictions were often informal, such as the case in 1932 when the Army Air Corps pressured Boeing into refusing to sell their advanced technology Model 247 airliner to Japan. "In confidential correspondence, Boeing officials expressly reassured the Air Corps that none of the company's advanced airliners would be sold abroad unless the government approved."[3] The Neutrality Acts of the late 1930s were an attempt to prevent the U.S. from getting embroiled in the wars of Europe and Asia due to arms exports. However, due to the depression, few in the U.S. Congress wanted to cut all weapons exports off entirely. So, the U.S. continued to export weapons to a few selected belligerent nations such as Nationalist China, while denying them to others, such as Ethiopia or Spain.

From the beginning of World War II in September 1939 until the Japanese attack on Pearl Harbor in December 1941, the Roosevelt Administration faced numerous legal and political obstacles in its efforts to aid first Great Britain and later the

[1]Donald Stoker, *Britain, France and the Naval Arms Trade in the Baltic 1919-1939* (Frank Cass, London, UK, 2003).

[2]Ibid.

[3]Roger Bilstein, *The Enterprise of Flight: The American Aviation and Aerospace Industry* (Smithsonian Institution Press, Washington DC, 2001).

Union of Soviet Socialist Republics (USSR). Occasionally, the administration flat out broke the law as when it delivered half a million surplus rifles to the British in the early summer of 1940.

Driven by sympathy with China and by Japan's aggressive overall policy, the Roosevelt Administration began to increase pressure on Japan in 1938. While this policy failed to deter Japan from attacking Pearl Harbor, it did serve to weaken the Imperial War machine. The State Department began with what was termed a "Moral Embargo." On July 1, 1938, Charles W. Yost, chief of the Department's Office of Arms and Munitions Control, notified the 148 U.S. aircraft manufactures and exporters who had registered with his office that only with "great regret" would he issue export licenses for warplanes and their munitions without naming Japan specifically."[4]

The policy evolved into full scale economic warfare culminating in the dollar freeze of July 1941, which effectively cut Japan off from purchases of oil and other essential commodities. It is important to note that much of the impetus for this policy came from relatively low level diplomats and military men, such as Assistant Secretary of State Dean Acheson. These men were ready to punish Japan much harder then their superiors wanted to.

During the war, ideas about the role of science both in the war itself and in the post war era were an important part of the intellectual discourse. On the left, it was often assumed that science would automatically make the world a more socialist place. Others such as George Orwell had their doubts. Writing in October 1945, more than a month after the Japanese surrender, he asked:

> But is it really true that a scientist, ...is any likelier than other people to approach nonscientific problems in an objective way? There is not much reason for thinking so. Take one simple test, the ability to withstand nationalism. It is often said that science is international, but in practice the scientific workers of all countries tend to line up behind their own governments with fewer scruples than are felt by the writers and artists. The German scientific community, as a whole, made no resistance to Hitler. Hitler may have ruined the long-term prospects of German science, but there were still plenty of gifted men to do the necessary research on such things as synthetic oil, jet planes, rocket projectiles, and the atomic bomb. Without them the German war machine could never have been built up.[5]

After 1945, U.S. leaders were led to assume that it would take the USSR at least ten years or more to develop their first atomic weapon "Truman and his advisors knew that sooner or later the Russians would develop their own bomb, but they were all surprised at how soon it actually came."[6] This was the first of many intelligence failures involving nuclear weapons. In fact, the Soviet regime gave the development of these weapons the highest priority, their program also benefited from an excellent espionage network in the U.S., Canada, and the United Kingdom (UK) as well as from several home grown men of genius, notably Andrei Sakharov. The U.S. reaction to the first successful Soviet nuclear weapons test in 1949 and the subsequent war in Korea, where the U.S. was surprised by the

The policy evolved into full - scale economic warfare

[4]Edward Miller, *Bankrupting the Enemy -The US Financial Siege of Japan before Pearl Harbor* (Naval Institute Press, Annapolis, MD, 2007).

[5]George Orwell, *Orwell in Tribune, As I please and other writings 1943-1947*, Paul Anderson ed. (Politicos, London, UK, 2006).

[6]John Ranelagh, *The Rise and Decline of the CIA* (Simon and Schuster, New York, NY, 1987).

excellent performance of the MIG-15 fighter and its British-designed engine was to try and insure that such leaks did not happen again. Stalin was skeptical that Britain would sell these engines– "What kind of a fool would be willing to sell his secrets!" he had reportedly said."[7]

The late 1940s and early 1950s were the heydays of large-scale managerial research. Norbert Wiener wrote that "I consider that the leaders of the present trend from individualistic research to controlled industrial research are dominated, or at least seriously touched by, distrust in the individual that amounts to distrust in the human."[8] This environment, which engendered more secrecy than the previous generation of academic scientists, became a subject of controversy. Much of this was caused by political, or specifically left wing, concerns rather than any real desire to promote the free circulation of ideas. The battles between Robert Oppenheimer with his conventionally leftist sympathies and Edward Teller whose anti-Communism and unabashed patriotism, based in part on his immigrant experience, was mirrored by debates over how much to trust the Soviet Union. As one protagonist put it:

> "As President Reagan never tired of saying, 'nations do not develop mistrust because of arms. Rather, they develop arms because of mistrust'. Western mistrust has been based on the Soviets' seventy year record of repression within and aggression beyond its borders"[9]

These debates continued to one degree or another until the end of the Cold War. One example was the 1948 controversy surrounding Edward Condon who had been director of the National Bureau of Standards and was accused of having ties to the American Soviet Science Society. While the publicly available evidence against Condon was never released, Vannevar Bush made clear that he had showed a "lack of proper care in the types of remarks he has made and the type of associates he has sometimes had."[10]

The U.S. not only lacked the skills needed to effectively locate and neutralize, in a timely fashion, Soviet spy networks, but it was also helpless in the face of a world wide propaganda campaign that was aimed at "McCarthyism." Of course, there were legal abuses in the 1940s and 1950s, but the Soviet goal was not to protect U.S. Civil Liberties, but to make life as hard as possible for America's counterintelligence operations. It also became a powerful political issue that helped discredit and drive apart liberals and conservatives.

In the same period, the U.S. was providing Europe with reconstruction aid under the Marshall Plan and with military aid as well. At the same time, European states did not want to give up their trade relations with the states on the other side of the Iron Curtain. The danger for them was that Americans, who were engaged in a global cold war and had little patience with those who accepted U.S. aid and protection while flirting with the enemy, would react in a negative fashion.

Europeans and Americans needed a way to make certain that U.S. political support for the Marshall Plan and for Europe's security remained intact. "The conservatives claimed that Marshall Aid, taken together with other commitments, exceeded the limits of American resources and discouraged Europeans from putting their own house in order."[11] The Coordinating Committee for

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[7]David Holloway, *Stalin and the Bomb* (Yale University Press, New Haven, CT, 1994).

[8]Norbert Weiner, *Invention, The care and feeding of ideas* (MIT Press, Cambridge, MA, 1993).

[9]Kenneth Adelman, *The Great Universal Embrace Arms Summitry, A Skeptics Account* (Simon and Schuster, New York, NY, 1989).

[10] G. Pascal Zachary, *Endless Frontier Vannevar Bush, Engineer of the American Century* (Free Press, New York, NY, 1997).

[11]Michael Hogan, *The Marshall Plan America, Britain and the reconstruction of Western Europe*

Multilateral Export Controls (CoCom) was established in 1949; the U.S., UK, and France and the Benelux states were the first members. Norway, Denmark, Canada, and West Germany joined in 1950, with Portugal and Japan joining in 1953, and Australia in 1989. CoCom was never a formal organization. It is often described as nothing more than a Gentleman's Agreement, yet it was one of the most effective tools of U.S. economic diplomacy throughout the Cold War. "Confidentiality was a necessary part of the early Cold War compromise that created CoCom; for several west European states, participation in a system of economic discrimination targeted against communist states was of dubious legality and potentially explosive politically."[12] Europe and Japan were concerned about the restrictions that CoCom put on their trade, and the U.S., while often inconsistent and arbitrary, kept up the pressure for more and more restrictions.

It was the Soviet system itself that failed to keep up with its foes

U.S. economic warfare against the USSR and vice-versa was a fact of the Cold War. At some times, U.S.-USSR politics, such as détente, placed inhibitions on the effort, but the economic warfare never fully stopped and was ready to be activated when political circumstances changed. One key turning point was the Soviet invasion of Afghanistan in December 1979. The economic pressure put on the USSR in the 1980s by the Reagan Administration was not simply confined to export controls, but included a wide variety of actions, including urging the Saudis to ramp up oil production to drive down the price. This savaged the Soviet's main source of hard currency income and pushed the price of their operations in Africa, Latin America, and Asia up to unsustainable levels. In his memoirs, Reagan wrote that in the early days of his Administration "It seemed clear to me that in time Communism would collapse of its own weight, and I wondered how we as a nation could use these cracks in the Soviet system to accelerate the process of collapse."[13]

Export controls, even though they were a source of U.S.-European friction, made life extremely difficult for the Soviets. The U.S. effort changed the trading environment, and instead of being offered credits at below market rates and price discounts on their purchases, the Soviets had to pay premiums to middlemen working through intelligence organizations to buy essential modern industrial equipment. A 1982 U.S. government report said that: "The overwhelming majority of what the United States considers militarily significant technology acquired by and for the Soviets was obtained by the Soviet intelligence services and the East European intelligence services."[14]

Having to work through intelligence services not only made the technology acquisition process expensive and vulnerable, but it also slowed it down at the very moment when computer technology development was accelerating in the West, particularly in America. It was the Soviet system itself that failed to keep up with its foes. One former senior U.S. intelligence officer expressed that:

> …the computer's power is useless unless the data it processes is accurate. And this means that any political or economic system which wishes to stay abreast of the surge in technology must give millions of people access to a broad range of accurate data. Any system based heavily on state control of

1947-1952 (Cambridge University Press, Cambridge, MA, 1989).

[12]Michael Mastanduno, *Economic Containment, CoCom and the Politics of East West Trade* (Cornell University Press, Ithaca NY, 1992).

[13]Ronald Reagan, *An American Life* (Simon and Schuster, New York, NY, 1990).

[14]Douglas McDaniel, *United States Technology Export Control, An Assessment* (Praeger, Westport, CT, 1993).

> information or that permits its bureaucracy to provide skewed data must reform itself or slip backwards technologically and economically.[15]

The more difficult the U.S. and its allies made it for the USSR to buy technology in the West, the more they had to depend on their own flawed system. This lead to such things as the well known "exploding television" phenomena and often to integrated weapon systems that failed to defeat Western ones. This was particularly evident during the Arab-Israeli wars of 1967, 1973, and 1982. For example, Syria's Russian-supplied air defense system, and a good part of its air force, was wiped out by Israel during the1982 Israeli war in Lebanon.

On June 9th, during a major attack on the SA-6 batteries, the technological competition between East and West, in a clash of investments valued at billions of dollars, ended with a conclusive victory by the West. At least twenty-two Soviet MIGs, of both models, were shot down, (in addition to seven others that had been downed since that morning), constituting between one-quarter and one-third of the Syrian force. Not a single Israeli aircraft was downed.[16]

For the U.S., the interest to open new markets in the late 1980s and early 1990s was strong. The U.S. trade deficit was always a problem, but it was the politics of the time that ended up determining the fate of U.S. export controls. At the time, the center-left opposition in America was, naturally, looking for themes that could be used to discredit the Reagan and Bush Administrations. The trade deficit was a good one, combined with the ease with which they could generate a fear that the world was going to be taken over by export oriented "neo- mercantilist" powers such as Japan and West Germany.

This theme, reiterated in articles, studies with titles like "Japan as Number One", and novels and movies, lead to a mild form of paranoia vis-à-vis Japan and a feeling that America's computer industry needed to be supported the same way that Japan or other Asian nations supported theirs. "At the growth rate of 1963-73, Japan would overtake the United States in real per capita income by 1985, and total Japanese output would exceed that of the United States by 1998."[17] This fear combined with the cultural affinity that many industry leaders had with leading Democrats made the whole question of export controls an important issue in the 1992 election.

When it comes to strategic sales, politics is never far away. In 1975, there were the Lockheed bribery scandals coming on top of Watergate. This was followed by the congressional investigations into the Central Intelligence Agency (CIA). It was then revealed that contracts to some foreign countries were designed to have, as a part of their price, a series of payments to consultants who had helped to facilitate the deal. These consultants, in turn, allegedly paid bribes to people in positions of responsibility. Among the more notorious of those who were alleged to have received the bribes were Japan's Yoshio Kodama and Prince Bernhard of the Netherlands.[18]

These revelations lead to the enactment of the Foreign Corrupt Practices Act (CPRA), which put the U.S. in the forefront of the international struggle against corruption, even though this was to handicap the U.S. economically over the years. "As a practical matter, the U.S. remains virtually the only country that vigorously prosecutes its

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[15]Daniel O. Graham, *Confessions of a Cold Warrior* (Preview Press, Fairfax VA, 1995).
[16]Eliezer Cohen, *Israel's Best Defense, The First Full Story of the Israeli Air Force* (Orion Books, New York, NY, 1993).
[17]Paul Krugman, *Pop Internationalism* (MIT Press, Cambridge MA, 1997).
[18]Walter Boyne, *Beyond the Horizons, The Lockheed Story* (St. Martins Press, New York, NY, 1998).

companies for bribing foreign officials."[19] Nevertheless, this law has become in part, the model for international anti-corruption legislation. American pressure on its trading partners was partly responsible for this as was pressure from international civil society including non-governmental organizations and the media.

In 1992, the CPRA was perceived as a U.S. government obstacle to America's need to export. The idea that the U.S. should suppress imports by means of taxes on consumers and should promote its exports "by any means necessary" gained ground. What was odd about this was that those who promoted this in the name of "industrial policy" saw it as aimed against military allies, in particular against Germany and Japan, and they saw America's foes such as the USSR as being nothing more than targets for a new export drive.

Between 1989 and 1993, much of the focus of U.S. economic sanctions activity had switched from the Soviet Union, which ceased to exist in December 1991, to China, whose 1989 Tiananmen Square "crackdown" caused the U.S. and other Western nations to cut-off weapons exports and to restrict China's access to sensitive technology. China, however, was not the USSR, the economic reforms of the Deng era had profoundly changed its economy, which became in many ways a conventionally mercantilist one on the Asian model, while still remaining politically a one-party Communist state. From a U.S. standpoint, China does not believe in supporting a universal Communist revolution and has pursued a strategy that is closer to that of pre-1914 Germany than to anything that ever came out of the Soviet politburo.

…China tried hard to develop a privileged position for itself

[19]Michael Marinelli, "Policy perspectives: is U.S. business hampered by foreign corrupt practices ban?" *World Trade Magazine*, 1 September 2007.

Complicating relations was the heritage of the U.S. quasi-alliance with China aimed at the USSR. American support for China in the 1970s and 1980, had rarely involved arms sales, a few helicopters and other items. The U.S. had encouraged others, notably in Europe and in Israel, to help to update the People's Liberation Army (PLA), whose forces had not received any serious injections of new technology since the Sino-Soviet split in the early 1960s.

In his memoir, President Reagan's Secretary of the Navy, John Lehman, wrote that "the most functionally important was the fourth and final agreement to undertake a program to modernize Chinese destroyers and frigates with modern technology, enabling them to carry out effective antisubmarine warfare."[20] While the U.S. had to be careful not to overtly state that the relationship was aimed at the USSR, this was in fact the case. There was also the pull of the Chinese market; American businessmen have been trying to develop a Chinese customer base since the late 18th century. China meanwhile has centuries of experience in exploiting foreigners for their own purposes. The Chinese from necessity had made manipulation of the strong by the weak into a fine art."[21]

It should be recognized that neither Americans nor Chinese have a very good record of being able to achieve their national goals through trade. In the 1960s, China tried hard to develop a privileged position for itself in the newly independent states of Africa through a combination of trade, aid, and military assistance. For the most part, this failed since most African states preferred to trade with the West and to obtain their weapons from the USSR. China's relatively successful mercantilist export policy combined with its technological espionage effort, gives it advantages that the USSR never had.

[20]John Lehman, *Command of the Seas* (Scribners, New York, NY, 1988).

[21]Barbara Tuchman, *Stilwell and The American Experience in China* (Grove Press, New York, NY, 1971).

These include: unimpeded access to the capitalist world's banking system; and to the higher education establishments of the U.S. and to a lesser extent, Europe.

For the U.S., trying to contain China's military growth and at the same time to integrate it into the world community is a tough balancing act. Unfortunately, politics tends to undermine any attempt to build a sensible and balanced long term strategy. This problem has lead directly to the current situation. America's current export control system is the direct result of politics. The Clinton Administration abolished the CoCom in late 1993 as a relic of the Cold War.[22] Concomitantly, many of the export control functions that had been handled by the State Department and by the Department of Defense (DOD) were transferred to the Commerce Department. Commerce strived for mercantilist trade promotion, limited only by the Constitution and by the structure of the American economy. This policy led to high-technology trade with China that involved the launching of U.S. commercial satellites on the Chinese Long March rocket.

The Chinese Long March failures between 1992 and 1996 and the U.S. made communications satellite they were carrying were compromised. Loral and Hughes assisted with the accident investigations and in the process leaked valuable technological information that supposedly helped China to improve the performance of its ballistic missiles.[23] A Pentagon report quoted by one critic of the U.S. trade policy towards China said:

> The provision of technical assistance in connection with the failure investigation to the Chinese by Hughes in the design, engineering, and operation of the Chinese launch vehicle and the Hughes satellite constitutes a "defense service" within the meaning of the State Department's International Traffic in Arms Regulations (ITAR) under the Arms Export Control Act (AECA).[24]

Combined with revelation of Chinese espionage aimed at U.S. nuclear weapons labs this set off a political firestorm. In March 1999, a congressional investigative panel was about to announce China's theft of information on nearly every U.S. nuclear weapons design, due in part to the incompetence of the Clinton administration Justice Department.[25]

In the end, the Congressional investigation was inconclusive. Congress did, however, find evidence of a very large Chinese espionage program aimed at U.S. military and technological secrets.[26] In order to counter this program, they recommended strengthening the U.S. export control regime. "In addition the panel called for stricter Defense Department controls on satellite

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[22]Under CoCom rules, the West experienced the greatest period of prosperity and economic growth in the history of the human race. The new set of international export rules that replaced CoCom, the Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies, is more loosely organized with more limited institutional structures.

[23]Eligar Sadeh, "Bureaucratic Politics Run Amok: The United States and Satellite Export Controls," in this issue of the journal.

[24]Bill Getz, *Betrayal, How the Clinton Administration Undermined American Security* (Regnery, Washington, DC, 1999).

[25]Dan Stober and Ian Hoffman, *A Convenient Spy, Wen Ho Lee and the Politics of Nuclear Espionage* (Simon and Schuster, New York, NY, 2001).

[26]Any improvement in the ability of a state, such as China, to land thermonuclear weapons onto American cities is something that no politician can afford to ignore. No matter how ambiguous the intelligence information the merest hint that such an improvement in the nuclear weapons that could be aimed at the U.S. homeland required some sort of response from the U.S. Congress.

launches in China."[27] In a divided government, there are limits on what the legislative branch can do to force a President of a different party to do its will. In the absence of any possible effective cooperation from the Administration, the Republican majority in Congress ordered in 1999 that communications satellites and all their components be placed on the munitions control list and thus, fall under ITAR regulations. This was a blow to U.S. policy that sought to promote U.S. exports with fewer national security limitations. The Commerce Department would no longer be able to issue export licenses for commercial satellites and their components. The impact of this change was both far reaching and unexpected.

Over the last eight years, the ITAR regulations have done serious damage not only to U.S. efforts to sell commercial satellites, but also to NASA's science and human spaceflight programs. "They have also proven a wonderful stimulator of international cooperation without U.S. participation."[28] This damage is due to the way the U.S. government works. The State Department's enforcement of ITAR regulations is a good example. The delays in processing space-related ITAR paperwork was due to a lack of trained personnel, and the people needed to deal with the paperwork were not engineers or people with a military background who could recognize when a certain bit of technology was dangerous and when it could be exported. These were lawyers who, by the nature of their training, would impartially and blindly enforce the law, no matter how much damage they were doing to the nation. "Scott Pace noted that U.S. ITAR regulations were an inartful response to globalization that created the risk of losing satellite manufacturing capability and influence."[29]

ITAR, as currently practiced, is a form of economic warfare practiced by the U.S. to try and achieve broad national security interests. "Evidence is beginning to emerge that it harms the sector and undercuts and erodes our economic competitiveness and forces international partners to go it alone."[30] Even though the domestic satellite industry and its component suppliers have been hurt, the U.S. will not give up the use of sanctions and other forms of economic pressure. They are an essential part of American statecraft, even if they are often used in crude ways and lead to outcomes that are increasingly counterproductive.

[27]Bill Getz, *Betrayal, How the Clinton Administration Undermined American Security* (Regnery, Washington, DC, 1999).
[28]*The Space Report* (The Space Foundation, Colorado Springs, 2006).
[29]Ibid.

[30]Ibid.

The American Bubble: International Traffic in Arms Regulations and Space Commerce

Professor Roger Handberg

Department of Political Science, University of Central Florida

International space commerce in the United States (U.S.) has entered into a period of great uncertainty regarding its current and future competitiveness and marketability of its products. This question arises because the U.S. with regard to space commerce remains frozen in a posture established first during the Cold War. The concern then was that no critical technologies be made available to U.S. enemies and their fellow travelers. The former were obvious while the latter were more problematic since that group also included states with which the U.S. wished to establish more positive relations including international trade. The mechanism used to monitor and control that trade process is the International Traffic in Arms Regulations (ITAR) regime applied by the U.S. Department of State. The issue is whether ITAR is still of the same value in a post-Cold War world and whether their enforcement might take a different approach. As will be discussed, changes in their application began especially toward the Cold War's end, but those changes were largely reversed due to a combination of domestic politics and international uncertainty. The question is whether the ITAR as presently implemented meets the strategic interests of the U.S. or is their unintended effect one of undermining the U.S. ability to influence international trade with regard to space technologies. For other categories related to arms, the ITAR supports U.S. policy objectives even though their application is often characterized by excessive slowness and rigidity in application.

ITAR and the Cold War

In the aftermath of World War II, the U.S. along with other states constructed a number of international and national institutions aimed at fostering international trade and economic growth. The Bretton Woods meeting during World War II led to agreements in 1944 establishing a system of international financial institutions to govern monetary policy among states. U.S. national interests led to this effort, building strong trading partners and allies in the post-war world. However, subsequent political events in Europe and Asia raised concerns about the future, the Cold War. The Cold War was a global military-economic-ideological competition between the U.S. and its allies, and the Soviet Union and those states aligned with it. In this context, a third collection of states emerged who professed nonalignment with either antagonist; a group that grew in numbers with the dismemberment of the colonial empires.

Trade between the U.S. and the Soviet block countries also incorporating the People's Republic of China was at best minimal and usually virtually nil. For these other states that were not U.S. allies, the U.S. established trade relations based on demand for their products. That meant that most underdeveloped states had very limited trade with the U.S. except for extractive industries. Cold War competition often brought the U.S. and the Soviets into direct political competition - a competition in which trade relations became an important foreign policy tool. The argument made was that expanding trade with a nonaligned state would incline its leadership to favor the U.S. in other matters. The difficulty was that in many instances, the products desired by the underdeveloped state were such that they might have military value and could be forwarded on to U.S. adversaries. Such items included various electronic goods and services. The U.S. for

reasons of national security and protection of its existing trade advantage wished to monitor and control these items sales and their future export. Allies were considered less of a problem, but there was the possibility that corrupted officials could facilitate export of otherwise forbidden items. The U.S. wanted to ensure that the prohibitions were enforced so recipients of otherwise controlled items would be on notice that forwarding those items to states otherwise forbidden would have consequences, no further exports to the offending state and criminal penalties for individuals violating the law.

The mechanism used during the Cold War was the Coordinating Committee on Multilateral Export Controls (CoCom). Technology transfer questions were resolved through this process, which later was incorporated into the Arms Export Control Act of 1976. This Act identifies those items that should be regulated because they are deemed defense articles and defense services. The result is the ITAR licensing process through the Munitions Control List (MCL) of space technologies that are explicitly covered under the Missile Technology Control Regime. MCL became the mechanism through which trade can be controlled and channeled. Evaluation of proposed sales was handled by the U.S. Department of State with significant input from the Department of Defense (DOD). This combination of reviewers, it was confidently expected, would provide the strongest control over leakage of military secrets since both departments define themselves as protectors of U.S. national interests as an institutional priority. What was more intrusive is the requirement that government monitors had to authorize and often attend any meeting where technical information was to be exchanged.

The task before the regulators grew more complicated over time as dual use technologies became more prevalent. For example, computer technologies from their onset had clear military applications. As the commercial sector grew and information technology became more sophisticated, the commercial versions were often more powerful than the military ones, capable of ever more powerful operations. Their value to potential adversaries became more apparent with the implication that their dissemination needed to be monitored and regulated to prevent hostile parties gaining access. However, political realities were such that information technologies were more easily exported with few exceptions than space technologies. This reflected in part the reality that U.S. computer and chip makers were competing in a global market where their success was not guaranteed. Space technologies in the West were dominated by the U.S. until the 1980s and early 1990s as the Europeans first followed by the Japanese at a distance became strong competitors. As that occurred, rules became looser.

In the early days of ITAR, friend or foe in principle was comparatively easy to determine. Over time the picture grew more complicated in that many states were friendly with the Soviets and Chinese. That included North Atlantic Treaty Organization (NATO) members such as Great Britain who for example had diplomatic and trade relations with mainland China while the U.S. recognized the Republic of China (Taiwan) as the legitimate government. All this made applying ITAR more complicated since the evaluation becomes once removed. Clear language was placed in the regulations to prohibit transfer of certain exports to third parties, closing a backdoor method of technology acquisition. In principle, the loophole was closed, but clearly was not air-tight. Enforcement of indirect regulations remained an issue, but the disincentive for the foreign partners was that U.S. technology products were valued so that access to them was strongly preferred even if that mean enforcing U.S. rules seen as onerous: that was the price of access.

information technologies were more easily exported than space technologies

Until the 1980s, ITAR met its purpose of denying militarily useful technologies from U.S. adversaries and their allies. Any hindering of U.S.

trade was accepted as a necessary price to sustain national defense. Complaints arose in academic circles, but were generally discounted although a few exceptions were carved out to accommodate them, especially those doing scientific work employing spacecraft of differing types. Those objections by the academic community were met by Presidential National Security Decision Directive 189 dated 21 September 1985, that exempted fundamental scientific research from ITAR and MCL regulations.[1] This exception was reaffirmed by the Bush administration on 21 November 2001.[2] Earlier, in the Reagan Administration in 1984, U.S. satellites could be launched by international companies, explicitly Arianespace at their French Guiana launch faculty. Gradually, application of the prohibitions lessened in their strictures as the Cold War waxed and waned in intensity. Less advanced products including older computer types were sold to states formerly prohibited. This occurred in response to the rise of economic competitors to the U.S. among its allies; primarily Europe and Japan. Their perspective was more purely trade oriented demonstrated by their willingness to sell products to states that the U.S. would not. These products were not controllable by the U.S. since they had developed independently. The actual degree of independence is unclear given the increasing internationalization of many areas of science and technology. In fact, in the late 1980s, the U.S. was lagging in certain technology areas, especially computer-based technologies. So, any U.S. trade restrictions were receding in importance given these alternative sources.

[1]Rachel Lehmer Claus, "Space-Based Fundamental Research and the ITAR: A Study in Vagueness, Overbreadth, and Prior Restraint," *Santa Clara Journal of International Law* 2 (2003).

[2]Julie T. Norris, *Restrictions on Research Awards, Troublesome Clauses*. A Report of the AAU/COGR Taskforce. Washington: Association of American Universities, 2004, http://www.aau.edu/research/Rpt4.8.04.pdf (accessed 6 September 2007).

Cracks Within the "ITAR Wall"

Given that national security drove the development and implementation of ITAR, changes in that environment could impact their application. Over time, the resurrection of Europe and Japan as major economic agents subtlety changed their role. The U.S. found that its strictures against export of various technologies were increasingly ignored. By the late Reagan administration, the general issue of how to treat such exports to formerly embargoed states had risen to levels within the U.S. government that a presidential decision was required. President Reagan agreed to the possibility of using Chinese or Soviet launch vehicles. This debate took place within a context in which the U.S. and the Soviet Union and China were moving toward more normal relations including economics. This included the possibility that their lift vehicles could be used to launch U.S. built communication satellites (COMSATs) into orbit. This presented an interesting situation since the U.S. was by far the dominant builder of communications satellites– a status the U.S. had aggressively defended for years.[3]

Using other states' launch vehicles was a major gesture toward globalizing the world economy. On the other hand, this willingness to reconsider the question reflected a perception that in the aftermath of the January 1986 Space Shuttle Challenger accident, the U.S. launch industry had fallen behind its international competitors.[4] The debate whether to lessen ITAR to accommodate proved an extremely contentious debate. The debate was between what could roughly be described as the controllers and those interested in expanded world trade. The controllers were those who argued that national security should trump any trade considerations regardless of temporary lessening of tensions. The risks of transferring

[3]Roger Handberg, *International Space Commerce: Building from Scratch* (Gainesville, Florida: University Press of Florida, 2006).

[4]Roger Handberg, *The Future of Space Industry: Private Enterprise and Public Policy* (Westport, Connecticut: Quorum Books, 1995).

militarily relevant technologies to potential adversaries were still considered too great.

Expanded trade supporters argued that the U.S. benefited from the opening up of this area of economic activity. That expanded economic ties would help ameliorate long term antagonisms and foster closer cooperative ties, a win-win situation. The risks of any inadvertent technology transfers could be mitigated by establishing certain procedures limiting what was made known to the launch operator. Clearly, some tech transfer would occur simply because U.S. companies would have to insure that Soviet or Chinese launch operations could properly handle the payloads.

The then President Bush authorized the licenses to be issued as the trade advocates successfully argued that normalized trade relations were in the national interest. Licenses to export were authorized, but protective measures were taken.[5] The payloads traveled in sealed containers with U.S. security personnel constantly present to stop any attempts to examine the satellites. Sufficient information was provided to allow the satellite to be properly mounted for release once orbit is achieved. The understanding was that whatever information was released would not materially assist the Chinese or Russians.

Chinese Long March boosters were thought less reliable, and thus less of a competitive threat

An integral part of the controversy was the growing schism between the satellite builders and the launch companies. The latter were under intense stress as the Europeans with the Ariane 4 lifters were dominating the launch markets. The Chinese and Russians added even more competition since until the security restrictions were lifted in the late 1980s and early 1990s, their launchers were excluded from carrying U.S. payloads. The split also came over the question of costs – U.S. launchers were legacy carriers from earlier generation converted missiles and more expensive than their international competitors. Opening the doors to new launch vendors did not totally eliminate U.S. launch providers' advantages since U.S. government payloads were still only flown on U.S. flag carriers. The new competitors also benefited from cost differentials between western prices and the artificial price structures of authoritarian states. The collapse of the Soviet Union further expanded this price gap when the Russian economy effectively went into free fall.

U.S. launch providers may have lost the fight over entry of new competitors into the field, but other restrictions were imposed. Given the artificial pricing structures inherent in socialist political systems, the U.S. demanded that quotas be imposed on each– without such a quota, American COMSATs would be available as payloads. Since U.S. COMSAT payloads constituted ninety percent of those available worldwide, failure to agree to these quotas meant "de facto" no market because Arianespace handled most European payloads, the balance of the available payloads. The quotas differed with the Soviets-Russians being the most intense since their lifters were seen as the most reliable and competitive. Given the mystery associated with the Chinese space program, Chinese Long March boosters were thought less reliable, and thus less of a competitive threat. Both quotas were for a specified time period. In fact, neither competitor used up its quota with the collapse of the COMSAT boom in the 1990s, the quotas were not renewed.[6]

Ironically, the schism between the satellite builders and the launch providers faded as mergers ended with Boeing and Lockheed Martin as the major vertically integrated players. Through their mergers and launch alliances, the two dominated American space industry. Their international alliances, Sea Launch (Boeing) and

[5]Eric Choi and Sorin Niculescu, "The Impact of US Export Controls on the Canadian Space Industry," *Space Policy* 22 (2006).

[6]Handberg, 2006.

International Launch Services (Lockheed Martin) tied various former Soviet launch providers into American space industry.[7] Competition was not eliminated as Arianespace remained the industry leader, but was severely constrained. Over time, the Chinese through aggressive marketing and price competition became major players in launching U.S. satellites to orbit. This can be seen in their incorporation into the Iridium launches, sixty-six satellites plus six spares. All the major launch competitors were involved.

Walls Fall, But Are Rebuilt

With the arrival of the Clinton administration in office in January 1993, licensing under ITAR was eventually moved to the U.S. Department of Commerce in 1996. Earlier in October 1992, a subset of COMSAT technologies had been moved from the Department of State to the Department of Commerce for licensing purposes. This was in line with both administrations' desire to foster trade relations in the aftermath of the Soviet Union's collapse. The goal was engaging the world through strong economic linkages, especially former socialist states including Russia and China. Given the Department of Commerce's mandate toward expanding trade, the obvious outcome was a general loosening of ITAR restrictions.[8] These moves were not universally greeted with acclaim by the controllers who felt the U.S. was giving away the store while incurring great risks to national security. Their concerns were shared by many Republican conservatives whose views of the former Soviet Union and China were much more negative than was official policy. The situation was ironic in that the skeptics were among those who usually strongly supported business interests of which trade was a major component.

[7]Andrew J. Aldrin, "Technology Control Regimes and the Globalization of Space Industry," *Space Policy* 14 (1998).

[8]This was heightened by the presence of Ron Brown, a close personal associate of President Clinton as Secretary of Commerce, whose primary mission was growing U.S. trade with other states.

Reversal came disguised in the shape of launch accidents in which Chinese Long March vehicles failed during lift off. American COMSAT payloads were total losses. In addition, lives were lost in the villages just outside the spaceport; the exact total was never officially announced although twenty seven was the number given for one accident. As is customary with such flight failures, a post accident investigation was launched. For the Chinese, conducting this investigation successfully, meaning finding a cause for the accident that could be corrected, was absolutely essential. An incomplete or otherwise distorted investigation would fail to satisfy the insurance investigators, meaning Long March vehicles became uninsurable. No insurance meant any possible western payloads became unavailable. Government payloads are effectively self insured while commercial payloads owners normally purchase insurance on the open market. Flight failures raise future insurance rates or make the vehicle uninsurable.[9]

The subsequent investigation included participation from all involved parties, meaning primarily the Chinese government as operators of the launch vehicle and the payload owners, meaning the satellite builders. Most satellite contracts give up control over the satellite after its safe arrival and check out on orbit to insure proper operations before the customer assumes control. Hughes Aerospace was the COMSAT builder and participated in the investigation – Boeing later bought Hughes and assumed its role in the joint investigation and its aftermath. Given the economic stakes, the investigation had to be thorough, which meant delving into technical aspects which raised flags among skeptics of trade with China. In the resulting process, technical information beyond that already made available was exchanged in part because the Chinese initially claimed the accident had been possibly caused by some defect with the payload itself. In order to refute this possibility, technical information was exchanged in greater detail. The resulting investigation indicated that launch vehicle operations were the cause.

[9]Handberg, 2006.

However, as knowledge of the investigation and the extent of the technical information exchange became known, a drumbeat of criticism arose in the U.S. Congress fueled by the growing perception of China as a future military rival akin to the old Soviet Union. The argument was that the Chinese, in launching U.S. COMSATs, were obtaining knowledge that helped upgrade their missile capabilities.[10] In addition, Republican politicians' animosity toward President Clinton added to the intensity of the debate. The debate grew larger into a charge that Chinese industrial-military espionage was penetrating the trade process and U.S. national weapons labs. In fact, a scientist, Wen Ho Lee, at Los Alamos National Laboratory of Chinese heritage was accused of nuclear espionage; the charges were ultimately dismissed. The political storm over China and its efforts to gain American secrets waxed in intensity.

The U.S. House of Representatives established an investigatory commission to examine the entire question of Chinese spying. The Cox Commission report completed in 1998, but not made public until 1999, became the basis for congressional action.[11] An amendment was added to the 1999 DOD authorization act ending the Department of Commerce's primary role in ITAR licensing. The Department of State was returned to its previous position as licensing agency with major input from the DOD. This change was aimed at increasing national security scrutiny of any license requests. There were no directions to stop or severely reduce trade with China specifically or any other state. However, the greatly heightened political sensitivity of license requests to export to China was obvious– a fact the bureaucracy was fully aware of and prepared to act on immediately.

[10]Joan Johnson-Freese, "Alice in Licenseland: U.S. Satellite Export Controls since 1990," *Space Policy* 16 (2000).

[11]*Report of the Select Committee on U.S. Security and Military/Commercial Concerns with the People's Republic of China* (Cox Report), House Report 105-851, Washington: U.S. House of Representatives, 25 May 1998.

United States Space Commerce in the Bubble

Changing the approver meant at least a more restrictive or cautious view of export applications of space technologies to China regardless of any precautions taken. The crunch came almost immediately with an export license for a Chinese COMSAT built by Hughes was put on indefinite hold. That particular license had too many political negatives to allow immediate approval. In fact, the parties eventually gave up and the COMSAT was sold elsewhere. Symbolically, the political point was made almost immediately even though implementation of the new process proved more complicated than expected.[12]

In addition, the Department of State encountered issues regarding its personnel and their competence and uncertainty as to what was politically acceptable. State lacked sufficient trained personnel able to process the license applications. Hiring and training staff represented a major challenge, which was only slowly overcome given federal hiring procedures. What proved more unsettling was the narrow view by the license examiners. The political sensitivity of the question heightened their caution with rules being interpreted in the closest manner possible. The result was a classic example of unintended consequences.[13]

…the Chinese …were obtaining knowledge that helped upgrade their missile capabilities

As indicated above, high-technology exports to China were immediately quashed generally with any exceptions carefully vetted. Other results of the change were more unsettling. First, there was a dramatic slowdown in the time necessary to gain approval.[14] For U.S. space industry, this delay

[12]Johnson-Freese.

[13]Ibid.

[14]Joan Johnson-Freese, "Life After the Cox Report: Technology Transfer and Export

generally hurt their ability to compete globally. Each exchange of technical information or meeting to discuss such information with international personnel had to be sanctioned in advance through Technical Assistance Agreements, imposing significant disruptions upon normal business operations. These procedures made U.S. space technologies less competitive or not competitive as other states, such as the Europeans, aggressively moved in to fill the void. U.S. space technologies could now be replaced without degradation in performance, something not true earlier.

Second, Great Britain, Canada, and NATO allies were placed under the same degree of scrutiny as China – the original impetus for the change. Beyond embarrassment, the treatment of class allies as adversaries put a temporary crimp in U.S. high-technology trade with them, a restriction that was quickly lifted but the political and trade damage was done.[15] Given the perceived erratic nature of the ITAR process, at least one European space company removed any U.S. content from its products – removing U.S. ability to compete with other suppliers for that company's COMSATs.[16] Other manufacturers of space technologies began to reduce the amount of American content in their products as a way to reduce U.S. interference in their ability to sell to whomever they wished. In fact, the European Space Agency advertises on its website regarding an "ITAR-free SpaceBus 4000B2."[17]

Third, efforts by space industry to reverse this negative outcome by reusing the statute fell on deaf ears in Congress. Why these efforts failed is a mix of motives including reaction to events after September 11, 2001 and heightened concerns about a resurgent Russia and surging China. The latter raised fears of possible future military confrontations in which space technologies would be major assets in the event of war. Administration policy emphasized a go it alone approach to many world issues– an approach that required the U.S. be dominant. Loss of its technological edge would leave the U.S. exposed to its enemies. Weakening the ITAR regime was seen as counterproductive to long term security interests.

Ironically, ITAR from its initiation was premised on a world in which U.S. space technologies were the cutting edge. Successive presidential administrations worked to sustain that edge, which then could - with caution - be used in trade. The effect, it was thought, was to discourage other states with a few exceptions from competing with their own space technologies. U.S. policy consistently tried to keep its allies and others tied to the U.S. The costs of competition were sufficiently high that most states would not compete if they had ready access to high quality U.S. products.

Beginning in 1986 with the Space Shuttle Challenger accident, that strategy has been chipped away. First in launch technologies, the U.S. fell behind in the global marketplace – that dominance had been artificially sustained by Space Shuttle subsidies that evaporated in the aftermath. Second, the changes in ITAR implementation cut U.S. trade ties with its existing customer base and rendered U.S. space technologies much less competitive in world markets. Customers lost are difficult to recover since satellite contracts come at intervals, not continuously. Assuming that the quality is roughly comparable customers are unlikely to return to a supplier thought more difficult and arbitrary.

The Future, Such As It Is

What has occurred is that the U.S. has succeeded in placing its space technology export trade in a "bubble." Penetrating the bubble requires buyers to negotiate an often slow and arbitrary ITAR

Controls," *Pacific Telecommunications Review* (August 1999), web.ptc.org/library/ptr/3q99/freese.html (accessed 15 August 2005).

[15]Peter de Selding, "Satellite Buyers Blast US Rules," *Space News* (5 April 1999).

[16]Antonella Bini, "Export Control of Space Items: Preserving Europe's Advantage," *Space Policy* 23 (2007).

[17]SeeThales-Alena, telecom.esa.int/telecom/www/object/index.cfm?fobjectid=28086 (accessed 15 September 2007).

licensing process. Potential customers are being driven to other suppliers, and states capable of developing such space technologies, now as a result of U.S. actions, are encouraged to further develop their own equivalents. Once those steps are taken, it is difficult for those states to reverse their course. The reality is that choice, the U.S. has chosen to render its space industry less competitive.[18]

By less competitive, we refer to the reality that other states are replacing the U.S. in the market place. In addition, U.S. policy, contrary to ITAR's purpose, is forcing other states to become more heavily engaged in developing their own space technologies. The U.S. loses out when it becomes isolated within the global market place. Other states and their space professionals can no longer interact easily with U.S. professionals. Both sides lose, but the damage affects the U.S. more in the loss of cross-fertilization of ideas and technologies.

[18]See Aldrin, 1998; and Taylor Dinerman, "Fixing ITAR: The Saga Continues," *The Space Review*, 16 May 2005, http://www.thespacereview.com/article/374/1 (accessed 16 September 2007).

Bureaucratic Politics Run Amok: The United States and Satellite Export Controls

Dr. Eligar Sadeh

Associate Director, Eisenhower Center for Space and Defense Studies

The case of export controls of United States (U.S.) commercial satellites is characterized by bureaucratic politics leading to policy outcomes that are not rational, i.e., the desired outcome of national security is not met and commerce in the satellite sector is harmed. The constraints to rational policy making are a result of competition, conflict, and protectionism, the "bureaucratic politics," among the relevant actors including the U.S. President and Congress, Department of State (State), Department of Commerce (Commerce), and Department of Defense (DOD). It is bureaucratic politics that result in policies for licensing the export of commercial satellites that are far from orderly, stable, and predictable.[1]

The crux of the political issue revolves around bureaucratic control and jurisdiction over the licensing process for export of commercial satellites. Since commercial satellites represent a dual-use space technology,[2] bureaucratic politics exist between the framing of export controls as a matter of national security versus a matter of business and commerce. The national security advocates, among them the president, congress, State, and DOD, view commercial satellites and the related technologies as items to be controlled for export within the same legal regime that controls export and trafficking of arms. State, through the Office of Defense Trade Controls Policy, is the bureaucratic entity that governs this regime, known as the International Traffic in Arms Regulations (ITAR) and the associated Munitions Control List (MCL). DOD, through the Defense Threat Reduction Agency (DTRA), assists State in implementing its regulatory authority.

The commercial space advocates, among them the president and congress, especially from 1988 to 1998, Commerce, and the aerospace and defense industries, view commercial satellites as an indicator of U.S. leadership with a strong market share in the global commercial satellite sector. Logically, the way to regulate export of these satellites is through the legal regime that governs dual-use technologies used commercially. This is the Export Administration Regulations (EAR) administered by the Commerce Bureau of Industry and Security. Commerce governs exports through the Commerce Control List (CCL). From 1992 to 1999, this regime applied directly to the export of commercial satellites.

This commercially-oriented approach enabled China to compete within the U.S. market for the launch of commercial satellites. From 1992 to 1996, the Chinese Long March rocket failed in launching commercial satellites manufactured by U.S. companies Hughes Space and Communications (purchased by Boeing in 2000) and Space Systems Loral. As required by the insurance companies covering these companies' assets, investigations into the launch failures were concluded and submitted to Commerce for approval. Commerce then authorized Hughes and Loral to communicate the technical reports to the Chinese launch officials. The transfer of the reports sparked political controversy over the statutory authority of Commerce to allow such a

[1] Joan-Johnson-Freese, "Alice in Licenseland: U.S. satellite export controls since 1990," *Space Policy* 16:3 (2000).

[2] Commercial satellites are clearly intended for commercial use and applications, but do represent applications and technologies that could be used for military purposes and military satellite development.

transfer without the proper review and oversight by the State Department.

Specifically, the controversy focused on the export of knowledge dealing with the reliability of space launch vehicle technology, and more generally, was linked to the issue of ballistic missiles and U.S.-Chinese relations. Congress investigated this issue of transfer through the *Report of the Select Committee on U.S. National Security and Military/Commercial Concerns with the Peoples' Republic of China* (known as the *Cox Report*), and determined that Hughes and Loral transferred to China, in violation of U.S. export control laws– the Arms Export Control Act of 1976 and the ITAR regime– missile design information and knowledge that improved the reliability of the Chinese Long March rocket useful for civil and military purposes.[3]

Dual-use technologies…are viewed as sensitive items to be controlled.

The congressional response led to the National Defense Authorization Act for Fiscal Year 1999 that directed sole export control responsibility to the State Department using the ITAR/MCL regime for commercial satellites. State's jurisdiction began in March of 1999, and continues through this writing in 2007. According to many space leaders, the application of ITAR to commercial space technologies is a misapplication of the regime and is one of the top space policy issues requiring congressional redress.[4]

International and Domestic Environments

To assess the case of export controls and commercial satellites, it is important to first explain how national security and commercial space advocates' respective policy preferences, needs, wants, demands, and expectations, are influenced by the international and domestic environments. The international and domestic environments date back to the Cold War and the issue of how to control dual-use technologies. The concern, then and now, is that such technologies can be used for the development of arms that can lead to proliferation of ballistic missiles, and nuclear, biological, and chemical weaponry. Dual-use technologies with these potential applications are viewed by national security advocates as sensitive items to be controlled.

One aspect of control lies with the statutory authority within the U.S. for dual-use technologies. This authority lies with the Export Administration Act (EAA) of 1979 in which congress delegated to the executive branch the legal authority to regulate foreign commerce by controlling and licensing exports. EAA is the domestic environment from which the Commerce Department's EAR regime emerged. Of note, the EAA expired in September 1990; reauthorization of EAA took place for short periods with the last incremental extension expiring in August of 2001. Since then, no new congressional legislation has been passed to either reauthorize or rewrite EAA, and the regime functions on the basis of presidential authority under the International Emergency Economics Powers Act.

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[3] *Report of the Select Committee on U.S. National Security and Military/Commercial Concerns with the Peoples' Republic of China* (United States House of Representatives, 1999). See http://www.house.gov/coxreport (accessed 11 December 2006).
Both Boeing and Loral were fined by the U.S. federal government for the export violations and both companies paid fines in 2002. Boeing was also charged with similar export violations concerning Sea Launch– a joint venture with Russian, Ukrainian, and Norwegian companies– during this same period.

[4] *The Space Report: The Guide to Global Space Activities* (Space Foundation, Colorado Springs, Colorado, 2006); and *Space 2030: Exploring the Future of Space Applications* (Organization for Economic Cooperation and Development, Paris, France, 2004).

Within the context of the post-September 11, 2001 (9/11) environment and the resulting emphasis on national security, at times to the detriment of commercial interests, the congressional failure to act on the EAA further strengthens and maintains the State-led ITAR regime for control of commercial satellites. Furthermore, the origins of the EAA are Cold War related and originate from the Export Control Act of 1949. Even though the EAA of 1979 represents a lessening of restrictive export control in comparison to the Export Control Act and subsequent amendments to that Act, the legal regime is a relic of Cold War international politics and national security rivalries.[5] EAA has not been sufficiently adapted as an export control regime for the post Cold War international environment of non-traditional security concerns, developments in space technologies, capabilities and applications, and the emergence of global commercial space activities.

A second aspect of control deals with the Arms Export Control Act of 1976, the basis for the ITAR export control regime. This regime was also established during the Cold War environment and has not undergone any statutory changes. Further, neither State nor DOD made any changes to the implementation modalities of any of these Cold War regimes.[6] During 1999-2000, both the president and congress noted the need to review the arms export control regime to streamline the processing of applications for export licenses. Neither State nor DOD acted on these recommendations. The issue of delays and the cost of bureaucratic compliance in the granting of export licenses is one of the key concerns of the commercial space advocates; these concerns translate into an economic issue for the commercial satellite sector. The economic issue also posits a barrier to entry for new space commercial companies, often referred to as alternative space, that are attempting to enter into existing markets, such as space launch services, or to develop new markets, such as space tourism. A third aspect dealing with the control issue exists at the international level. In 1949, a multilateral export control regime called the Coordinating Committee for Multilateral Export Controls (CoCom), involving North Atlantic Treaty Organization (NATO) allies, was established. This regime mirrored U.S. domestic controls as established with the Export Control Act of 1949. CoCom advanced restrictive export controls on sensitive dual-use technologies at the multilateral level. The regime was dissolved in 1994 and replaced in 1996 by the Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies. The Wassenaar Arrangement, as compared to CoCom, lessened export controls of dual-use technologies at the international level and is more loosely organized with more limited institutional structures. It relies on consensus by state members, frequently resulting in a lowest common denominator approach for multilateral export control, minimal reporting requirements preventing pre-export consultations among state members, and a lack of authority among state members to block transactions of other state members.[7] In addition, the liberal multilateral regime that emerged with Wassenaar no longer sought multilateral control over commercial satellite technology or expertise. This development influenced the U.S. environment and raised national security concerns when dealing with the export of dual-use technologies. In the end, the liberalization of the international legal regime is a factor that favors the national security space advocates' position and their preference for ITAR as the regime to control and license exports of commercial satellites and the related technologies.

[5]Ian F. Fergusson, *The Export Administration Act: Evolution, Provisions, and Debate* (United States Congressional Research Service, The Library of Congress, updated May 5, 2005).

[6]*Defense Trade, Arms Export Control System in the Post-9/11 Environment* (United States Government Accountability Report, February 2005).

[7]Ian F. Fergusson, *The Export Administration Act: Evolution, Provisions, and Debate* (United States Congressional Research Service, The Library of Congress, updated May 5, 2005).

Communications Channels

Given an understanding of the policy preferences of the relevant actors, what then are the communications channels through which the policy of export control is applied? This is largely a function of the relevant bureaucratic strategic cultures. The strategic cultures of the national security advocates versus the space commerce advocates frame the political debates and arguments. This framing represents the organizational lenses, images, and "rules of the game" regarding export controls of commercial satellites.

Commercial space advocates frame the export control issue through the lens of foreign availability of technology. The contention is that the proliferation of technology cannot be effectively controlled and U.S. dominance of space technology cannot be assumed. The globalization of space commerce points to the fact that unilateral controls will not stop foreign states from acquiring the technologies. Thus, U.S. dominance in space commerce is diminished, while foreign businesses win new markets and gain incentives to enter into new markets.[8] All this is complicated by the fact that as space commerce is increasingly global many components in the commercial satellite sector are manufactured worldwide and considered commercial commodities. ITAR is not designed to deal with the global nature of the industry and the outcome provides an incentive for foreign commercial satellite developers to reduce dependence on U.S. satellite components due to delays associated with the U.S. export licensing process. The emerging trend is one where U.S. satellite manufacturing companies, which must adhere to ITAR restrictions, are at a growing disadvantage as inventory of "ITAR-free," i.e., no U.S. manufactured components, satellites expand abroad.[9]

In addition to the economic argument, space commerce advocates see a link between national security and robust export control industries, and favor an export control regime that is streamlined, less complex, and not an impediment to exports. As an example, Commerce presumes that the issuing of an export license is routine unless good cause can be shown otherwise. Space commerce advocates argue that national security is undermined when exports are impeded, resulting in the loss of U.S. market share. The limitation of U.S. satellite components through export controls leads to greater foreign research and development (R&D) investments in this area. In turn, these foreign R&D investments can be leveraged to achieve parity and even surpass the U.S. technological lead. In conclusion, space commerce advocates frame commercial satellite technology as possessing no inherent strategic or military relevance, a view shared with the state members of the Wassenaar Arrangement with the exception of the U.S.[10]

ITAR is not designed to deal with the global nature of the industry

[8]Export controls on space commerce create risk through uncertainties, result in losses of markets because of impacts on space industry's ability to serve international markets, and prevent efficient industry restructuring to the forces of globalization. See *Space 2030: Exploring the Future of Space Applications* (Organization for Economic Cooperation and Development, Paris, France, 2004).

[9]In Europe, Alcatel Alenia Space and the European Aeronautic Defense and Space Company have both made it company policy to build ITAR-free commercial satellites.

[10]Wassenaar Arrangement state members in addition to the U.S., include: Argentina, Australia, Austria, Belgium, Bulgaria, Canada, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Latvia, Lithuania, Luxembourg, Malta, Netherlands, New Zealand, Norway, Poland, Portugal, Republic of Korea, Romania, Russian Federation, Slovakia, Slovenia, South Africa, Spain, Sweden, Switzerland, Turkey, Ukraine, and United Kingdom.

In contrast, the national security advocates maintain that there is a need to control commercial space exports as sensitive military technologies. This control prevents the proliferation of technologies that could be used by hostile, rogue states against the U.S. or its allies, secures DOD's reliance on the commercial sector for R&D as a result of declining defense budgets in the 1990s, and sustains the U.S. military use of commercial space assets for operations, including commercial satellites for telecommunications and remote sensing purposes. National security is framed in ideological and "war-fighting" terms– limiting the diffusion of technology advances U.S. foreign policy interests and enhances national security. The framing of export control as a national security issue compelled congress to place commercial satellites and related technologies within the authority of the ITAR/MCL regime.[11] The Chinese Long March "satellite scandal" discussed earlier and the events of 9/11 served to strengthen this worldview and weaken political attempts to reform the export control regime.

Conversion and Outputs

Since the view herein is that the case of export controls is one of bureaucratic politics leading to policy outcomes that are not rational, how the relevant organizations interact, i.e., the U.S. President and Congress, and the relevant bureaucracies, is crucial to understand. A rational policy-making process suggest outputs that serve the desired communications channels of at least one group of advocates. In this case, the policy outputs, albeit unintended, do not ideally realize the policy preferences of either the national security or commercial space advocates. On one hand, ITAR can damage national security by placing legal and bureaucratic restrictions on the U.S. military use of commercial space assets that rely on a robust satellite industry.[12] This includes risks to the military use of: commercial satellites for operational support; advanced satellite technologies developed in the commercial sector; and foreign suppliers for satellite components and services needed for military operations. On the other hand, export control of commercial satellites vis-à-vis ITAR has made the U.S. space and satellite component industry less competitive internationally and contributed to a weakening of U.S. market position.[13]

How did the issue of export controls of commercial satellites result in policy outputs that are not desired? The answer to this question lies in the nature of how the relevant political actors serve as conversion structures. Prior to 1992, export control of commercial satellites fell within the purview of the ITAR regime, but beginning in 1988 President Reagan began to loosen export restrictions on commercial satellites to keep U.S.

[11]It is the sense of the U.S. Congress that business interests must not be placed above national security interests. See Strom Thurmond National Defense Authorization Act for Fiscal Year 1999.

[12]Thomas Moorman, *U.S. Space Industrial Base Study* (Booz-Allen & Hamilton: McLean, Virginia, 2000).

[13]Since the application of the ITAR regime for export control of commercial satellites in March 1999, U.S. global share of commercial satellite manufacturing revenues fell to 41% in 2005 from 51% in 2000; U.S. commercial satellite component suppliers captured 90% of the global market in 1995, whereas by 2000 they retained only 56%; U.S. satellite firms lost approximately $5 billion between March 1999 and the end of 2001; and, from 1999 to 2004, it is estimated that U.S. share of the lucrative geostationary satellite market declined by 16%. See *State of the Satellite Industry Report* (Futron Corporation, Washington, DC, June 2006); Robert D. Lamb, *Satellites, Security, and Scandal: Understanding the Politics of Export Controls* (University of Maryland, College Park, Center for International and Security Studies at Maryland, January 2005); *Space 2030: Exploring the Future of Space Applications* (Organization for Economic Cooperation and Development, Paris, France, 2004); and *State of the Space Industry* (International Space Business Council, Washington, DC, 2000).

industry competitive in global markets and to advance national space policy for the development of the commercial space sector. The following Bush and Clinton administrations shared these policy preferences and acted to these ends. Bush and Clinton used presidential legal authority to waive trade sanctions with China put in place through congressional legislation following the Tiananmen Square massacre. The sanctions waived included commercial satellites for export to launch on the Chinese Long March. The policy conflict between the president and congress set the stage for the Chinese satellite scandal and the resulting 1999 congressional legislation that reversed the loosening of export controls initiated by Reagan.

The theme of policy conflict continued as Bush made use of presidential authority to extend EAA and pocket vetoed a congressional bill that would have amended and extended the full EAA on a permanent basis.[14] In this bill, congress took more of a national security position on the export of dual-use items in conflict with Bush's post Cold War commercial view for the increased role of economic power in national security. Bush sustained this view by removing all items from MCL that were on the CoCom dual-use list. This led to split jurisdiction, from 1992-1996, between State and Commerce for export controls. An interagency review process initiated by Bush determined which of the dual-use items listed on MCL could be transferred to CCL. Under the Commerce Department's business-friendly licensing process, these transfers made it easier to export some commercial satellites for foreign launches. Less advanced commercial satellites were exported as commercial goods under the EAR regime. Throughout the story of commercial satellite export controls, State and Commerce have both sought influence and authority, and split jurisdiction was viewed by the actors as a compromise way to resolve this dispute.[15] Nevertheless, the differences in strategic cultures of each bureaucracy sustained the struggle for political influence over export controls.

the export regulatory bureaucracies at Commerce, State, and Defense lacked the requisite technical expertise

As a result of split jurisdiction, the technical parameters for determining whether commercial satellites should be treated as munitions or dual-use commercial goods became unworkable by 1995. One of the issues that emerged was that the export regulatory bureaucracies at Commerce, State, and Defense lacked the requisite technical expertise to determine which technologies to control as munitions versus which could be exported as commercial commodities.[16] This was exacerbated by the fact that regulatory monitors were asked to implement near impossible tasks– apply overlapping, self-contradictory rigid sets of rules and track all hardware for export without explicit guidance on what to protect for reasons of national security and what are commercial commodities. Consequently, split jurisdiction was abandoned as a policy preference by the actors. In October 1996, and until March 1999, congress assigned Commerce primary jurisdiction. Since then, commercial satellites and related technologies are listed on MCL and regulated for export by State.

The moves undertaken by the political actors to transfer jurisdiction to Commerce were met with countermoves by State export officials determined to exert their full authority to the extent permissible by law. The political process

[14]The congressional bill pocket vetoed by President Bush was the Omnibus Export Amendments Act of 1990.

[15]Marcia S. Smith, *Space Launch Vehicles: Government Activities, Commercial Competition, and Satellite Exports* (United States Congressional Research Service, The Library of Congress, updated 1 January 2006).

[16]*Preserving America's Strength in Satellite Technology, A Report of the CSIS Satellite Commission* (Center for Strategic and International Studies, Washington, DC, 2002).

underlying the transfer to Commerce's jurisdiction was characterized by bureaucratic politics and conflicts. Both export control bureaucracies sought regulatory authority and their self-interest to do so became a goal in-and-of-itself. The bureaucratic politics concept that "where you sit defines who you are" applies directly in this case; State and Commerce regulators were explicitly tied to the strategic cultural perspectives of their organizations. As policy preferences for Commerce's jurisdiction moved to fruition by 1996, State pursued enforcement regulations that made it increasingly difficult and costly for satellite companies to export if even a single component remained subject to State control through MCL.

Congressional reaction to the Chinese affair and the sustained efforts of national security advocates advancing their case for export controls led to congressional legislation that resulted in sole State jurisdiction in 1999. This action was reactive rather than rational. One indication of this is that the export violations committed by Hughes, Loral, and Boeing did not damage U.S. national security in any material way; the expertise transferred to China only marginally benefited Chinese missile programs by improving launch reliability.[17] Many of the breaches were little more than technical violations of State export control regulations dealing with services that could "in theory" be applied for national security purposes.[18]

The policy output of State jurisdiction is suboptimal; rather than seeking a compromise, State countered the preferred policy preferences of the commercial space advocates. Given the drive for bureaucratic self-preservation, State took the congressional mandate for sole jurisdiction and unilaterally implemented its approach, through administrative rule making, to realize its national security perspective.

This raises a number of issues. First is the issue of what was intended by the *Cox Report* recommendations, which had prompted congress to give State commercial satellite licensing authority. It is not clear whether the recommendations intended to control the export diffusion of technology from solely a national security standpoint, or to control the technology diffusion in a way to satisfy both national security and commercial advocates' preferences. This ambiguity provided State the opportunity to advance their national security perspective. Concomitantly, officials at State expressed their desire to work with space commercial businesses by facilitating and approving ITAR applications, and viewed the political problem as rooted in the congressional mandate for State's sole jurisdiction and enforcement of the export control law.[19] In fact, State does approve the vast majority of export license applications.[20] The issue with the export control of commercial satellites within the ITAR regime is not one of denial of licenses, but rather in how State enforces the law. Enforcement leads to excessive delays and bureaucratic compliance with export regulations that are a cost to the commercial satellite sector.

What is also clear is that State is enforcing the law in ways that are not necessarily what congress intended, yet congress itself fails to act on this problem. To illustrate, the *Cox Report* called for: congressional reauthorization of EAA; continuous updating of the export control regime; and streamlining the licensing procedures to provide greater transparency, predictability, and

[17] *Report of the Select Committee on U.S. National Security and Military/Commercial Concerns with the Peoples' Republic of China* (United States House of Representatives, 1999).

[18] Robert D. Lamb, *Satellites, Security, and Scandal: Understanding the Politics of Export Controls* (University of Maryland, College Park, Center for International and Security Studies at Maryland, January 2005).

[19] Interview, Ann Ganzer, Director of the Office of Defense Trade Controls Policy, Department of State, The Space Show, 12 February 2006. See www.thespaceshow.com (accessed 4 June 2007).

[20] Since the listing of commercial satellites within the ITAR export control regime in 1999, only 1% to 2% of all export license requests are denied.

certainty. In all these areas, neither State nor congress took any substantive actions. Not only did State act unilaterally to do other than what was recommended by the *Cox Report*, but congress also failed in its basic oversight role to hold State accountable to congressional policy preferences. This dynamic, together with the events of 9/11, stalled reform advocates' efforts. Although there is pending legislation in congress to follow through on the *Cox Report* recommendations, the advocates are in the minority. The proposed congressional Satellite Trade and Security Act of 2001 went as far as to restore Commerce jurisdiction, though the measure failed to advance, and through the 110th Congress of today there have been no serious attempts to introduce subsequent legislation or to put the issue on the agenda.[21] Other barriers to reform include export risks and organizational constraints on expediting State's process for exporting commercial satellites.[22] These barriers stem from the fact that technical expertise at State and Defense is lacking. Even though some incremental advances in addressing these barriers have taken place, as recommended by the *Cox Report*, the policy lesson of spilt jurisdiction is that determining risk is in many ways unworkable and the control of satellite exports through the national security lens does not readily lend itself to streamlining the licensing process.

A congressional bill to expedite the State Department process for exporting commercial satellites, particularly to states considered friendly to the U.S., such as NATO allies and other major non-NATO allies, was signed into law in 2004. With this bill, every effort was made to allay national security concerns, while attempting to find ways to not only sell commercial satellites abroad, but to allow the transfer of information necessary to bid on new projects as well as respond to business requests for information on existing systems. Of note is that in 2000, following the *Cox Report* recommendations, congress allocated additional funds to State to allow for addressing the issues of technical expertise and expediting the licensing process. At that time, State unilaterally acted to shift these funds within the bureaucracy away from the congressional intent. The 2004 mandate by congress is more closely monitored, and State is working to deal with the expertise and delay barriers. One significant effort underway is the development of an electronic filing system for export licenses at State.

The policy dynamic discussed earlier, State countering Commerce, persisted under sole State jurisdiction. State unilaterally reversed the Commerce approach that exempted many items from requiring licenses,[23] extended ITAR controls to U.S. allies for commercial satellites,[24] and advanced regulations that required return of hardware to its state of origin for repair. State also issued retroactive regulations for the Technology Assistance Agreements (TAAs) governing technology transfers for satellites that had been licensed by Commerce. TAAs are required for marketing discussions and the exchange of basic

[21]In addition to the Satellite Trade and Security Act of 2001, congressional sponsors have proposed amendments to the Export Administration Act and other separate bills that would return export licensing authority for commercial satellites to Commerce.

[22]The inability to accurately measure risk to national security is one of the most serious problems for the system of export controls.

[23]Commerce exempted basic items, like screws and knobs for example, from export control.

[24]The Strom Thurmond National Defense Authorization Act for Fiscal Year 1999 included language that MCL shall not necessarily apply to the "export of a satellite or related items for launch in, or by nationals of, a state that is a member of NATO, or that is a major non-NATO ally of the United States." In implementing ITAR, State interpreted this exception to apply only to the mandated monitoring activities. Further, the expanded definitions of satellite related components, and the additions of defense technical services and space insurance business meetings as new areas needing export licenses, led to the bureaucratic "micro-regulation" of the U.S. commercial satellite industry in response to accusations initially related to China.

technical information with insurance companies and launch service providers for satellites exported and launched. State's retroactive approach created a situation where new technology transfer licenses and TAAs had to be issued for satellites already operating in orbit. State even acted to reverse Reagan's decision that exempted fundamental research information from an export license.[25] Export directives to control such information affect the National Aeronautics and Space Administration (NASA), universities, and industry R&D as they require licenses for any collaboration with foreign nationals on fundamental research. In addition, State and Defense practice intrusive monitoring, allowing monitors' access to proprietary knowledge. Despite this, industry has not objected in any direct way due to a fear of congressional reaction and their dependence on governmental contracts.[26]

Conclusions

The commercial satellite export case posits damaging consequences for U.S. technology and business leadership in space. The political process began with the incremental political liberalization of export controls in response to the changing international post Cold War environment and the rapid increase in space commerce globally. The process then transitioned to congressional action to overturn the then existing satellite export control regime in favor of Commerce jurisdiction. All the while, the process was driven by bureaucratic politics between Commerce and State. In the context of the post 9/11 world and the security concerns the attack generated, the general sense was that U.S. business and commercial interests should never trump national security interests. State succeeded in advancing their national security worldview as the U.S. national interest, a costly situation for commercial space and their advocates.

[25]In 1985, President Regan issued an ITAR exemption for fundamental research conducted at U.S. universities. National Security Decision Directive 189, 21 September 1985.

[26]In March of 2007, the Coalition for Security and Competitiveness, that does include a number of professional associations that represent the aerospace industry, began advocating for export control reform on dual-use items. See www.securityandcompetitiveness.org (accessed 25 June 2007).

Chasing Satellites: Identifying Export Control Problems and Solutions

John Douglass

Aerospace Industries Association President (Retired December 2007)

In a globalized world where the United States (U.S.) faces threats from terrorist groups, rogue states, and others, effective export controls remain essential to our national security. These controls keep our most advanced technologies, weapons, and equipment out of the hands of our adversaries and rivals— an increasingly difficult task.

With these emerging security and economic challenges, however, technological cooperation with friends and allies is critical. Global trade can leverage the technological competitiveness and innovation of the U.S. industry and our foreign friends to build interoperability, trust, and capabilities critical to keeping the nation secure and advancing our interests abroad. This cooperation strengthens America's technological edge, sustains the industrial base, and enhances economic security.

Technology trade and cooperation, which is often subject to export controls, play a central role in supporting the aerospace and defense industry's 630,000 American jobs.[1] According to Aerospace Industries Association (AIA) estimates, U.S. aerospace companies posted a $54.8 billion trade surplus in 2006, while the nation's merchandise import-export deficit exceeded $600 billion.[2] The aerospace industry exports 40 percent of its total product and, during some economic quarters, nearly 70 percent of its civil aircraft and components.[3]

The current U.S. export control system hurts the aerospace industry's ability to effectively support the nation's security and economic interests. This outdated system also increases costs and risk in our programs and closes off business opportunities with U.S. customers, partners, and allies. As a result, our friends abroad are losing trust in our ability to exchange technology in a timely and rational manner. These challenges are particularly acute in the space sector of the aerospace industry. Export control process and policy barriers continue to rise even as political, scientific, and business trends have led the U.S. to rely more heavily on foreign partners for cost-effective technologies, scientific talent, and sales and opportunities to sustain the U.S. industrial base.

Numerous studies, ongoing and recent, are aiming to establish a causal link between export controls and challenges facing the American space industrial base. These studies all focus on the impact of Section 1513(a) of the Strom Thurmond National Defense Authorization Act for Fiscal Year 1999, which shifted export control jurisdiction of commercial satellites and related items from the Commerce Department, which is responsible for licensing "dual-use" exports, to the State Department, which monitors the licensing of U.S. munitions list exports.

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[1] *Aerospace Facts and Figures,* www.aia-aerospace.org/stats/stats.cfm (accessed 5 November 2007).

[2] The Aerospace Industries Association (AIA) represents more than 100 regular and 180 associate member companies, and operates as the largest professional organization in the United States across three lines of business: space systems, national defense, and civil aviation. AIA represents a total high-technology workforce of 640,000 that manufactures products for customers around the world.

[3] *AIA Aerospace Facts and Figures*.

Challenges to the Export Control System

The U.S. export control system was designed during an era of U.S. technological dominance, a time in our history clearly defined by a bipolar security environment and bilateral trade. Protecting access to U.S. technology, the system's primary imperative, was much more easily accomplished under those circumstances. Trends in globalization, technology, and security threats have both redefined the system's standard of effectiveness and made the job much more difficult.

Globalization has created an interdependence between the U.S. and its foreign partners that is both valuable and irreversible. It is no longer possible, or even desirable, for American companies to have purely domestic supply chains or focus exclusively on the domestic market. Foreign-sourced technology is sometimes better and more cost effective, and foreign customers offer sales opportunities that can make up for shortfalls in U.S. public and private sector acquisition. The new flow of information and technology is no longer a bilateral exchange, but a multilateral network with each move often requiring an export license. These factors account for the eight percent annual growth rate in export license applications cited by the State Department in the last few years.[4]

Changes in the global security environment exacerbate the risk-averse licensing behavior.

The export control system is tasked with evaluating the export of each element of technology, from data to components to entire weapons platforms, for security risks. The private sector drives today's technological innovation at a level of complexity difficult to monitor, let alone thoroughly understand, by a government-operated export control system. Even modern "commercial" technology is increasingly sophisticated and arguably at some level capable of "military uses." Taken together, these two dynamics force the government to rely on industry, from primes to the lowest supplier, to know what licenses they should apply for and when, and woe to the company that gets the answers to those questions wrong. Liability concerns of the regulator and the manufacturer result in risk-averse behavior from both parties, causing the proliferation of both arguably unnecessary license applications that clog the system and of inordinately stringent decisions on what can be exported and under what conditions.

Changes in the global security environment exacerbate the risk-averse licensing behavior. Since the terrorist attacks of September 11, 2001, the U.S. has focused on addressing security threats from both traditional states and sub-state actors who can and do operate in the same places where the U.S. is sending technology. Moreover, our allies no longer share with the U.S. our position regarding the level or source of these threats, or the appropriate response to them. Consequently, licensing exports to even our closest allies can be viewed as risky to a government regulator.

In the end, both the political and economic resources necessary to address these trends have been absent in the U.S. export control system. Companies have repeatedly voiced concern that processing times are unpredictable and often extend 60 to 90 days before the review process is even initiated. Decisions and conditions on similar licenses can vary considerably and can, at times, even contradict the regulations governing the export control process.

All too often, discussions of the problems with the U.S. export control system move into esoteric realms of regulatory interpretation and legislative

[4]Opening Statement of Chairman Brad Sherman, House Subcommittee on Terrorism, Nonproliferation and Trade, Hearing on Exports Controls: *Are We Protecting Security and Facilitating Exports*, 26 July 2007.

intent, relying on anecdotal rather than verifiable justification. While there may be a vague consensus that some problems exist within the export control system, industry has struggled to convince the administration or U.S. Congress to take action, let alone provide compelling solutions.

Commercial Satellites and Why Studies on the Space Industrial Base Matter

The application of export controls to commercial satellites illustrates the impact of these trends and the futility of past attempts to achieve substantive policy change. To address the transfer of data from U.S. companies to Chinese authorities after the failed attempt of a Chinese rocket to launch a U.S. commercial satellite, congress passed legislation in the 1999 Strom Thurmond National Defense Authorization Act placing commercial satellites and related items on the U.S. munitions list. The transfer of commercial satellites, their components and any technical data to a foreign entity is now subject to the most stringent licensing treatment of the federal government, the International Traffic in Arms Regulations (ITAR) and its associated munitions list.

As a result, U.S. commercial satellite manufacturers forego sales to China or use of Chinese launch vehicles and obtain licenses for all other foreign sales or launches. The time, effort, and cost of obtaining these licenses are onerous, but manageable, given the downturn in sales opportunities for commercial satellites in recent years.[5] The consequences of this policy shift have been much more significant, however, for commercial satellite component manufacturers.

To respond to any Request for Proposal (RFP) from a foreign commercial satellite manufacturer, a U.S. component manufacturer must first obtain a license to send relevant technical and marketing data. While the queue for all munitions list export licenses has grown, each license in the queue has also become that much more complex and therefore takes that much longer to evaluate.

Assuming a U.S. component manufacturer gets a license in time to compete for and win a given contract, subsequent communications and hardware transfers between the U.S. manufacturer and its foreign customer are all subject to advance licensing requirements. Changes in the conditions of the transfer, such as allowing a new person in a foreign company to access the information or transferring information to another third-party, are commonplace in global manufacturing, but would result in a need for new licenses. Once a component on the U.S. munitions list is incorporated into any system, commercial or military, the government must give its approval, possibly with conditions, before that system is moved or sold.

The mounting frustration of foreign commercial satellite manufacturers under these circumstances is both reasonable and unsurprising. The ability of U.S. component manufacturers to respond to requests for information or meet shipment deadlines can be called into doubt when export licenses are required. In practice, regulators often interpret ITAR to require licenses for all U.S.-origin components, including nuts, bolts, washers, and hoses designed or modified for use in a commercial satellite, irrespective of how innocuous or low-tech they may appear. Since foreign manufacturers do not know who will eventually buy their satellites, they are wary of seeking permission from the U.S. government for the eventual movements of these components either to complete the manufacturing process or the eventual sale of what they believe is a purely commercial product. This is especially true if it means abandoning the Chinese market, to which foreign commercial satellite manufacturers have exclusive access in the absence of any U.S. competitors.

Two responses to these frustrations have negatively impacted American satellite component manufacturers. First, the number of foreign commercial satellite component manufacturers who would otherwise not have been viable competition against U.S. manufacturers has grown steadily. These foreign component manufacturers, unencumbered by

[5] *AIA Aerospace Facts and Figures*.

licensing requirements and often with the financial support of their home governments, have successfully taken away market share from U.S. companies.[6] The second response, a preference both state and unstated for acquisition of "ITAR-free" components by foreign commercial satellite manufacturers and their customers, has compounded the impact on U.S. commercial satellite component manufacturers.[7]

In the nine years since the Strom Thurmond National Defense Authorization Act, the aerospace and defense industry has been unsuccessful in arguing for a need to revisit the application of export controls on commercial satellites and related components. The external barriers to change can be traced, in part, to legitimate concerns about compromising U.S. national security interests with hasty policy adjustments and the strained relationship between the relevant congressional committees, the House Foreign Affairs Committee and Senate Foreign Relations Committee, and the State Department when it comes to addressing export control matters. These tensions have previously preempted any productive discussion of viewpoints, let alone identification of ways to improve the status-quo management of the export control system.

The aerospace industry also shoulders part of the blame. The industry's inability to provide definitive proof of the damage inflicted by the current system has been an obstacle to a successful campaign for this policy issue. Sympathetic officials within congress and the administration have, for years, asked for industry cooperation to quantify the impact of the regulations. The recent proliferation of government supported studies on export controls and the space industrial base are a response to the absence of reliable data.[8]

The initial explanation for this data void was to point out the challenge of isolating the impact of export controls on a loss of sales compared to a general downturn in the commercial satellite marketplace. There are times when companies lose contracts without being given a reason why or choose not to bid on a contract because they know they cannot meet RFP deadlines, which have shrunk considerably over the years as customers embrace greater options among non-U.S. component manufacturers, and no longer have to work with timetables convenient for U.S. manufacturers.

the industry's inability to provide definitive proof of the damage inflicted…has been an obstacle

The other challenge faced by our industry is the difficulty in acting collectively on such a sensitive issue. No company wants to be the "poster child" for export control problems, especially if it is trying to convince customers that it can be a reliable supplier in spite of export license requirements. In some cases, companies that may have faced enough challenges to overcome their hesitation to "testify" either decided to abandon the product line or went out of business.

Despite these challenges, interest in export controls has recently surged within the administration and the U.S. Congress for three reasons. First, security and economic cooperation in the international arena is the new status-quo for the government, the military, and the private sector. Second, compliance challenges with export control policies and processes are more complex. Compliance-related delays or failing to conduct business because of compliance requirements

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[6]Ibid.

[7]"China's Rocket Service Makes Inroads, Irks U.S.," *Wall Street Journal,* 5 October 2007.

[8]The Space Policy Institute, Center for Strategic and International Studies, Organization for Economic Cooperation and Development, Institute for Defense Analyses, and the Space Foundation have all completed studies on export controls and the space industrial base between 2001-2007.

have more apparent security, economic, and even civil impacts than ever before.[9] Third, compliance challenges are no longer just the concern of a few large companies. Suppliers are becoming more internationally oriented, despite a lack of experience and resources to navigate the maze of U.S. export controls. AIA and its partners in the Coalition for Security and Competitiveness have spent the last year supporting and spreading this growing interest. In the process, the hope is to create a hospitable policy environment for the results and recommendations of these satellite and space industrial base studies.

The Coalition for Security and Competitiveness

AIA is a founding member of the Coalition for Security and Competitiveness, an alliance of eighteen industry and trade associations committed to developing a modernized export control system. The coalition is advocating the development of a modern export control system that:

- accurately identifies and safeguards sensitive and militarily critical technologies;
- enhances U.S. technological leadership and global industrial competitiveness through more responsive and efficient regulatory management;
- facilitates defense trade and technological exchange with allies and trusted partners;
- supports a strong U.S. technology industrial base and highly-skilled workforce;
- and promotes greater multilateral cooperation with our friends and allies on export controls.[10]

A predictable, efficient, and transparent export control system should enable America's broader national security strategy. The coalition has argued that the current export control system lacks these three basic qualities. The government must do a better job of making decisions on export authorizations in a timely manner. The Coalition would like to see a system that can deliver decisions on 95 percent of all license applications in 30 days, not the current 55-plus days it often takes.[11] The license process must also be predictably consistent with applicable laws, regulations, and policies. Comparable export applications under the same conditions should receive the same or similar approvals in the same or similar time frames. The rules governing the license process must be interpreted and used consistently, and the U.S. industry and its foreign partners should be able to quickly and easily access the status of their applications. The current system is paradoxically hurting national security, U.S. economic strength, and U.S. technological competitiveness, and the problems will only continue to worsen if no action is taken.

The coalition has focused its first phase of action on improvements to the current system that could have an immediate, positive impact on predictability, efficiency, and transparency in license processing. These recommendations were intended to be measurable, attainable, and meaningful. The coalition also agreed to focus, at least initially, on process improvements that the administration could implement under existing statutes. Meanwhile, mindful of congressional

[9]For instance, during a hearing in July in the House Science and Technology Committee's Subcommittee on Space and Aeronautics, Tommy Holloway, chair of the congressionally-mandated International Space Station (ISS) Independent Safety Task Force warned that International Traffic in Arms Regulations (ITAR) restrictions and objections by NASA's International Partners (IPs) to signing what the IPs believe are redundant Technical Assistance Agreements "are a threat to the safe and successful integration and operation of the Station."

[10]Additional information on the Coalition for Security and Competitiveness and its associated proposals can be accessed at www.securityandcompetitiveness.org (accessed 15 November 2007).

[11]Ibid.

interest in this issue, the coalition is organizing briefings with congressional committees and offices on the importance of this issue and how the coalition's proposals will help pave the way for a complete reexamination of the system.

Since commercial satellites and their components are regulated by the U.S. munitions list, the coalition's defense trade proposals are profoundly relevant and cut across all parts of the federal government.[12] The coalition has called on the White House to restate the strategic policy principles that govern the operation of the U.S. export control system. This statement should highlight the need to capture the full security and economic benefits of prudent technology exchange with our friends and allies. The coalition also recommends the appointment of a senior director at the National Security Council to focus on conventional defense and dual-use export controls by separating these issues from the non-proliferation portfolio. The coalition has called for the creation of a new presidential advisory body to establish a dialogue between the executive branch, congress, and industry on defense trade and technology cooperation.

While the coalition is not challenging the administration's national security determinations on transactions, decisions need to be made consciously, consistently, and clearly at the policy-making level. This is especially critical for the rules governing the commodity jurisdiction process, a process that determines whether the State Department or Commerce Department has jurisdiction over an export authorization. A significant number of export licenses that clog up the current system may, in fact, be unnecessary if the interagency process that evaluates such transactions all follow the same regulatory interpretation.

In commodity jurisdiction and other policy-related cases where the interagency process must come to a consensus decision, an interagency appeals process for precedent-setting decisions would help ensure that policy and process are consistent and relevant to changing circumstances. Such quality control, or a review of licenses denied or "returned without action" (RWA), would be helpful at the transaction level.The coalition has offered defense proposals that will primarily require the leadership of the State Department to implement. The most immediate of these proposals is funding the hiring of additional licensing and agreements officers to handle the eight percent annual growth rate in defense license applications and the license backlogs that have ranged from 5,000 to 10,000 licenses in recent years.[13] In addition to advocating for extra personnel to handle this challenge, the coalition asked the administration to consider and develop new approaches to caseload management, particularly the licensing caseload generated by government programs with allies and partners. New management approaches are needed to reduce the number of authorizations related to a given program and to facilitate efficient interaction with program partners.

Finally, the coalition called for a more robust electronic system for processing licenses that enhances transparency. The system should track not only the current status of license applications across the entire interagency process, but also their transit times and next steps against mandatory timelines. The industry is interested in tracking licenses that require congressional notification from when they are first submitted to the government to when they are sent to congress for review.

[12]Statement of U.S. Government Accountability Office (GAO), Director for Acquisition and Sourcing, Ann Calvaresi-Barr, House Subcommittee on Terrorism, Nonproliferation and Trade, Hearing on Exports Controls: *Are We Protecting Security and Facilitating Exports*, 26 July 2007.

[13]See www.securityandcompetitiveness.org/proposals/show/2241.html (accessed 1 December 2007).

A New Approach to Export Controls on Satellite Components

There is a short-term, medium-term, and long-term way that the coalition's efforts can directly support U.S. commercial satellite component manufacturers and, by extension, the space industrial base. Given the status-quo legislative situation that places commercial satellites and related items on the munitions list, any adjustments that improve the current processing of munitions list export licenses by the State Department will be useful. Satellite component manufacturers would have a much easier time meeting their customers' deadlines and, almost equally as important, incorporating predictable timelines into communications and hardware deliveries to their customers. American and foreign satellite manufacturers using U.S.-origin components would also experience fewer delays in seeking approval for sales and launches involving third-party countries. Needless to say, all other space-related technologies controlled by the State Department would enjoy the same benefits.

In the medium-term, the coalition's call for a renewed dialogue on caseload management, specifically improved program licenses, could arguably be applied to the challenges faced by commercial satellite and component manufacturers. In the past, the aerospace industry has tried to take advantage of program licenses that grant pre-approval for a slate of transactions between U.S. and foreign customers and partners. Eligibility for these program licenses are currently restricted to major weapons programs. The paperwork required to prove compliance with the terms of a program license is more time-consuming than simply obtaining individual licenses for each transaction. Applying for a program license requires companies to lock in a significant amount of information on what and how they will be operating without much flexibility to address changes in export transactions. In the end, program licenses are less useful than continuing to apply for licenses for individual transactions.

The coalition has proposed that program licenses expand to include more than major weapons programs.

The coalition has proposed that program licenses expand to include more than major weapons programs. Ideally, these program licenses would cover transactions between U.S. companies and their foreign subsidiaries or parents, focused research and development (R&D) projects on critical technologies, such as anti-improvised explosive devices (IEDs) and missiles, and possibly even commercial satellite platforms. To be useful, these licenses must be more flexible and less onerous than the cumulative requirements for all license applications necessary for the same set of transactions.

In the long-term, a legislative fix and a coalition-supported regulatory fix will balance the national security and economic imperatives driving export controls on commercial satellites and their components. The legislative language currently references all commercial satellites and related items. To the surprise of congressional staff involved in the drafting of the original legislation, the State Department has chosen to interpret this language to eliminate any need to evaluate the risk of exporting a commercial satellite component. All commercial satellite components are instead licensed and treated as munitions list items:

> I feel some sense of responsibility for what happened," said David Garner, a retired Air Force colonel. Garner had helped put together the 1998 legislation that was designed to add commercial communications satellites— like those that had been implicated in the transfer of sensitive technology to the Chinese by a House committee led by then Rep. Christopher Cox— to the Munitions List, meaning that their export would be overseen by the

> State Department rather than the more permissive Commerce Department. That was, Garner said, exactly what he thought the legislation did.
>
> Shortly after the bill became law, he recounted a meeting where he and other officials discussed the legislation. At that time, he said, "we all had a pretty good sense of what we were going to do, and then the legal office of political affairs at State said, "Well, you know, all the parts and components on those comsats are captured, too." We all sort of looked at each other said, "I didn't write that. Did you write that?" None of us around the table believed that that's what we had done, but in fact that's what ended up."[14]

A legislative change that either eliminates the reference to "related items" or even adds a qualifier like "related items that have significant military application" would clarify congressional intent. The structure of the munitions list allows it to capture all items designed or modified for use by a specific munitions list line item, like commercial satellites. With the legislative change, commercial satellite component manufacturers could make a case, specifically a commodity jurisdiction request, to transfer an item back to Commerce Department control without immediately being turned away because of the legislation. Convincing lawmakers to explore such a change would likely require credible studies and recommendations that link export controls and damage to the space industrial base affecting U.S. security and economic interests.

A related and necessary step is adoption of the coalition's recommendations on commodity jurisdiction evaluations.[15] Existing export control commodity jurisdiction regulations, specifically sections 120.3 and 120.4 of ITAR, allow for flexibility in determining the risk of an export based on consideration of commercial availability as well as military and intelligence applicability. These ITAR sections are not being interpreted or implemented in a consistent and predictable fashion. Commodity jurisdiction decisions on components have been based on purely cosmetic modifications of commercial off-the-shelf technology. In addition, the Commerce Department's expertise in analyzing commercial applications of technology is not always valued appropriately. The coalition has requested enhanced oversight of the interagency commodity jurisdiction process to ensure it correctly and consistently follows existing regulations, and clarifying guidelines on the proper use of regulations and interagency input during the evaluation process.

The coalition is mindful that piecemeal improvements to the existing system will not allow it to effectively address the security and economic challenges and opportunities of the 21st century. For this reason, the coalition has begun discussing and identifying the key elements of a "model modern system" to compare with the existing system. The best long-term solution to addressing the negative impact of export controls on U.S. security and economic interests would be adopting key elements of this model system to better evaluate rationally, precisely, and efficiently the risks and rewards of U.S. technology exports.

The Changing Face and Fate of Export Controls

For years, export controls have been something of a "black art" in Washington, DC. Understood by few and misunderstood by many, the laws and regulations designed to keep sensitive U.S. technology in responsible hands have evolved

[14]See 26 February 2007, *The Space Review*, article by Jeff Foust.

[15]See www.securityandcompetitiveness.org/proposals/show/2241.html (accessed 5 December 2007).

slowly, while the global market for aerospace and the need for strong military alliances have flourished. Export control laws still remain arcane, but the potential for modernization is emerging on the horizon.

Through history, export controls were something one entity visited upon another. Whether it was the U.S. Congress placing restrictions on the administration, the administration on industry, or any one country on another, export controls have never been rooted in open political dialogue. That has changed noticeably in recent years, and the Coalition for Security and Competitiveness has expanded this dialogue through consultations at all levels of the interagency process and visits with almost every office of every member of the congressional committees of jurisdiction.

The administration welcomed the launch of the Coalition for Security and Competitiveness in March of 2007 and has spent the last few months reviewing its proposals. By end of 2007, assuming successful completion of the interagency review process and the absence of major opposition from congress, the administration will likely announce its plans to move forward on a number of coalition recommendations to make the U.S. export control system more predictable, efficient, and transparent.

The administration also recently proposed defense trade treaties with the United Kingdom (UK) and Australia that would reduce impediments to technology trade with those countries, while maintaining stringent security standards.[16] The outreach and ongoing dialogue by the administration has recently ramped up, and the resulting reception from congress has been warm. As the experience of the U.S.-UK treaty indicates, congress is now more willing than ever to consider new concepts in export control.[17]

Perhaps, the most compelling reason for this shift in congressional opinion is that the underlying justifications of export control have changed. America only benefits from its technological edge by sharing it prudently and can only sustain that edge by honing it with the innovations and contributions of our military allies and trading partners. Determining which countries and users get which pieces of that technology should vary not only according to their need, but also according to their demonstrated ability to protect what they get. The U.S. default position should hold that responsible states who work and fight alongside the U.S. should also benefit, when practical, from U.S. technology.

Another evolution is evident in who has been advocating for modernization of export controls. Traditionally, the high-technology defense industry has been interested in export control because its products were most likely to be controlled. With global markets opening, though, that industry has been joined by representatives of

[16]U.S.-UK Treaty text available at www.state.gov/t/pm/rls/fs/90740.htm, and U.S.-Australia Treaty text available at www.state.gov/t/pm/rls/fs/91763.htm (both accessed 15 December 2007).

[17]The U.S.-UK treaty referenced here deals with defense trade cooperation. This treaty permits the export of certain U.S. defense articles and services to the UK Government and select British companies that meet specific requirements, without U.S. export licenses or other prior approvals. It also ensures the continuation of the British policy of not requiring a license for the export of UK defense articles and services to the U.S. The Treaty will create an approved community of the two governments and selected defense companies. Most U.S. defense articles will be eligible to be exported into and within this community without prior U.S. Government licenses or other authorizations as long as the exports are in support of: combined U.S.-UK military or counterterrorism operations; joint U.S.-UK cooperative security and defense research, development, production, and support programs; specific security and defense projects that are for UK government use only; and U.S. government end-use. See U.S.-UK Treaty text at www.state.gov/t/pm/rls/fs/90740.htm.

every sector of American business. The Coalition for Security and Competitiveness brings together technology businesses as diverse as the National Association of Manufacturers and the U.S. Chamber of Commerce, who represent every sector of the economy.

U.S. businesses have woken up to the extent to which outdated export control provisions hinder America's ability to compete in the global marketplace. They have seen technologies widely available from competitors prosper, while we restrict U.S. companies from exporting functionally similar items. They see the reality of globalization in all facets of modern business and the pervasiveness of high-performance technologies in such transactions. In short, industry needs fewer licenses on no-risk and lowest-risk exports, with necessary licenses approved quickly enough to get the job done.

Future discussions on export controls, commercial satellites, and the space industrial base, spurred by effective government studies, should take lessons from the success of the Coalition for Security and Competitiveness. The coalition's proposals for export modernization focus on the crux of the issue: increasing predictability, efficiency, and transparency in the current system. The aerospace and defense industry is not looking to "de-control" exports irrespective of legitimate national security concerns, but merely to add speed and consistency to the process.

In the near-term, this can be done by increasing resources for export licensing agencies and finding more efficient ways to manage the risk of technology exchange. In the long-term, the challenge of increasing political resources, particularly oversight of policies and regulations, to ensure the quality and consistency of licensing and commodity jurisdiction decisions must be addressed. America's foreign allies also play a role by recognizing that, to maximize the security and economic benefits of technology exchange with the U.S., they must accommodate and address legitimate security concerns.

The U.S., and those joining the industrial push for export control modernization, is buoyed by the mounting recognition that improvements to the system will not interfere with legitimate national security concerns.[18] Dialogue among the agencies, congress and the industry remains critical. In the absence of such a dialogue, it would be easy to mistakenly assume that common ground in seeking to address the risks associated with technology exchange is not sought. Export controls have traditionally been about denying the "bad guys" any access to the "good stuff." That has to remain a core value. But, it is also more important than ever to make sure that the "good guys" have a pipeline to the "good stuff" and, when possible, that the "good stuff" is coming from U.S. manufacturers.

[18]Baker Spring, *A Step Forward in Reforming the United States Arms Export Control Process,* 9 April 2007 (accessed at http://www.heritage.org/Research/NationalSecurity/wm1416.cfm).

Defense Industrial Base Assessment: United States Space Industry

Final Report Summary, August 2007

This report focuses on the health and competitiveness of the United States (U.S.) Space Industrial Base, including the associated impacts of U.S. export controls. The Department of Defense, through the Under Secretary of the Air Force and the Space Industrial Base Council directed this study. An Air Force Research Laboratory, Materials and Manufacturing Directorate representative led an industry-government team and integrated the information gathered to prepare the study. The Department of Commerce's Bureau of Industry and Security developed and deployed the survey instrument and verified data provided by companies comprising the U.S. Space Industry. Team contractor support included the Universal Technology Corporation, Booz Allen Hamilton, The Tauri Group, Nortel Government Solutions which operates the Air Force Industrial Base Information Center, and Northrop Grumman Technical Services.

Executive Summary

In October 2006, the National Security Space Office (NSSO) initiated this space industrial base assessment. The purpose was to assess the health, competitiveness, and ability of the space industrial base to continue support of national security space requirements. Specifically, the goals were to: (1) evaluate the industrial, economic, and financial factors affecting the U.S. Space Industrial Base; (2) determine if U.S. export controls and practices are impacting space prime contractors and 2nd / 3rd tier subcontractors; and (3) develop findings and conclusions for the Space Industrial Base Council.

A team approach was taken to conduct the study. The government team project lead and integrator was the Air Force Research Laboratory Materials and Manufacturing Directorate (Industrial Base Program). The Department of Commerce, Bureau of Industry and Security (BIS) developed, deployed, and verified data collection from a survey of space industry companies, and the NSSO served in an oversight capacity.

The study involved a broad look at industrial base indicators and a detailed analysis of the BIS survey inputs. The BIS issued the survey electronically on 2 February 2007 and concluded it on 24 April 24 2007. The survey was sent to 274 space industry company/business units— the BIS received and verified 202 survey inputs for a 74% response rate. The team used tier levels aligned by typical business supply chain hierarchy to characterize the industry respondents. Prime contractors were Tier 1, subcontractors were Tier 2, and commodity suppliers were Tier 3. The study focused on three analysis streams including Global Marketplace / Competitiveness, U.S. Industry Health, and Export Control Impacts.

Global Marketplace and Competitiveness

Foreign competition is real and growing. Moreover, there is some evidence that U.S. export controls give foreign competitors a perceived advantage in marketing to non-U.S. customers. Segments of the U.S. space industry feel threatened competitively and see export controls as the main factor undermining their ability to compete for sales in foreign markets.

Sales and Market Share

Total global and total U.S. space sales have increased, mostly in services, for the 2003-2006 period surveyed. However, the U.S. share of the global market decreased. For example, the U.S. share of satellite manufacturing has decreased 20% for all commercial communication satellites (COMSATs) sales and 10% for geosynchronous orbit COMSATs since 1999. Defense funding, domestic non-defense services, and ground equipment dominate U.S. space industry sales. Export sales represent less than 10% of total U.S. company revenues annually from 2003-2006.

Competition

Industry's view on its competitiveness in the 2008–2012 timeframe is very positive with regard to the domestic market. In the foreign marketplace, there is a broad industry consensus on the difficulty in capturing sales. Industry identified strong foreign competition in spacecraft manufacturing, primarily in Europe, followed by the Asia-Pacific region. Companies also indicated U.S. export control requirements were the number one barrier to selling in foreign markets, followed by indigenous purchase preferences.

United States Industry Health

Overall, financial viability for the U.S. space industry is good based on publicly available company annual reports, with 70% of the companies considered at low risk. Twenty-five percent of the companies were considered at moderate or high risk (primarily commercial space services and manufacturers of materials for launch systems). Aggregate Research and Development expenditures grew an average of 8% per year since 2003, primarily in Tiers 2 and 3 as an investment in innovation by firms to remain competitive. The space workforce has grown 22% over the last 4 years.

Export Control Impacts

The industry survey captured information related to the added financial and labor costs associated with export sales, as well as, trends tied to processing International Traffic in Arms Regulations (ITAR) and Export Administration Regulations licenses. This analysis addressed process issues, cost of compliance, the unintended consequences of export controls, and suggested industry remedies.

License Process Issues

Impacts of export control processes vary by tier with more pronounced impacts at lower tiers. Although less than 1% of ITAR license applications were denied from 2003–2006, the reported loss of foreign sales due to ITAR was $2.35 billion, mainly due to lengthy processing times. The average processing time for Technical Assistance Agreements has grown to over three months.

Cost of Compliance

Export control compliance costs averaged $49 million per year industry-wide. Compliance costs grew 37% during the 2003–2006 period with the burden of compliance significantly higher for firms in the lower tiers.

Unintended Consequences

Foreign competitors leveraged their countries' more relaxed regulatory climate in marketing their products as "ITAR-free"— purportedly directly affecting U.S. companies' ability to compete. Some U.S. companies claimed the European Space Agency (ESA) directed European companies to find non-U.S. sources for space products, and ESA has also funded development of competing products to either avoid ITAR requirements, develop indigenous capabilities, or both.

Industry Remedies

Almost 60% of the recommended industry actions were to update U.S. export control lists more often to accurately reflect current global technology and the competitive environment. Nearly 23% of respondents recommended specific actions for streamlining the U.S. export control licensing process. Some firms also made recommendations to reform the Congressional review process.

Findings and Conclusions

The U.S. space industry has, in general, been healthy for the 2003-2006 period and very competitive domestically for both defense and commercial products and services; however, the global space market has changed significantly since 1998-1999 when the U.S. Government made major modifications to its overall export control

regulations for space-related products and services. The U.S. industry now faces strong and growing competition, primarily from European firms, and is losing market share in allied countries. Reportedly, ITAR has impacted U.S. competitiveness by encouraging other nations, in many cases our allies, to develop indigenous space capabilities and industries that now market globally.

Survey respondents reported that ITAR changes and the cost of export control compliance have directly or indirectly precipitated this increased competition. To maintain and enhance the U.S. position in the global space market, ITAR processes need to be frequently reviewed and adjusted, as appropriate. ITAR staffing at the U.S. Department of State and the Department of Defense's Defense Technology Security Administration should be reviewed and adjusted to ensure that personnel/funding levels align with the number of applications processed. Moreover, restrictions regarding sales to U.S. allies should be re-examined to reflect geopolitical and economic considerations.

President Issues Export Controls Directive

Reform United States Defense Trade Policies and Practices, 22 January 2008

President Bush issued an Export Control Directive today that will ensure that United States (U.S.) defense trade policies and practices better support the National Security Strategy. The package of reforms required under this directive will improve the manner in which the U.S. Department of State licenses the export of defense equipment, services and technical data, enabling the U.S. Government to respond more expeditiously to the military equipment needs of our friends, allies, and particularly our coalition partners.

The Export Control Directive mandates the commitment of additional financial and other resources, as well as procedural reforms that will expedite the processing of export license applications for items controlled by the U.S. Munitions List. Although license processing times will be reduced as a result of this directive, the Administration is committed to ensuring that existing measures to prevent the diversion of such items to unauthorized recipients remain strong and effective.

The specific actions directed by the President are listed below.

More Effective U.S. Export Licensing

- Additional financial resources and intelligence support will be made available for the timely adjudication of defense trade licenses.
- Guidelines will be issued that require a decision by the U.S. Government on defense trade export license applications within 60 days, absent a strong reason for additional time, such as a requirement for Congressional notification. Initial efforts in this regard have resulted in a nearly 50 percent reduction since April 2007 in the number of export license applications pending with the Department of State.
- The electronic licensing system will be upgraded to permit the submission of all types
-
- of defense trade licenses and to enable all agencies to access the same electronic information.
- The Secretary of State will update U.S. controls on exports involving dual and third country nationals from NATO and other allied countries.

A More Efficient Dispute Resolution Mechanism

- A formal interagency dispute mechanism will be created to allow for timely resolution of licensing jurisdiction issues involving the Departments of State and Commerce under the Commodity Jurisdiction (CJ) process. The National Security Council will also undertake a review to make sure the CJ process is efficient and timely.

Enhanced Enforcement

- A multi-agency working group will be established to improve procedures for conducting export enforcement investigations.

The directive reflects consensus recommendations from the National Security Council and the Departments of State and Defense. The Bush Administration is committed to working closely with U.S. industry to implement these reforms.

Program Annals 2007

EISENHOWER CENTER
FOR SPACE AND DEFENSE STUDIES

National Space Forum:
Towards a Theory of Spacepower

Summer Space Seminar

China Working Group:
China, Space, and Strategy

Future of Space Commerce Workshop:
Reducing Risks and Fostering Partnerships –
Synergies between Civil, Military, Commercial, and New Space

Space Based Solar Power Workshop

Improving Our Vision II:
Building Transparency and Cooperation –
Workshop on Space Situational Awareness Data Sharing

National Space Forum 2007: Towards a Theory of Spacepower

Institute for National Strategic Studies, National Defense University
Eisenhower Center for Space and Defense Studies

Colorado Springs, Colorado, January 2007

Charles D. Lutes

Senior Military Fellow, Institute for National Strategic Studies

The Spacepower Theory Project seeks to gain insight into human behavior in outer space. The project's overall objective is to develop a theoretical framework that helps to define, categorize, explain and anticipate ways in which "spacepower" may be pursued, how the various facets of spacepower connect to each other, and how they relate to the other instrumentalities of power that state and non-state actors may seek to achieve or retain.

Since 1957, spacepower has evolved from the first space age, where prestige was a primary motivation of activity, to the second (current) space age where the primary commodity of space is information. The next space age may well be defined by the creation of wealth in space and other celestial bodies. Throughout these phases, outer space activities provide a means for enhancing sociocultural, economic, and political power.

To reach the potential promise of space in these areas requires serious attention to the security aspects of the space domain. Security in space could be maximized by a situation in which unfettered access by spacefaring actors becomes a norm for amicable interstate relations; where such actors achieve a measure of protection against the aggressive or capricious acts of spoilers; and where real or perceived vulnerabilities among space actors are minimized. Creating a condition of enduring stability in outer space will depend upon how tensions between national interests are addressed and whether there emerges over time a convergent perception of what actions tend, on balance, to strengthen or undermine stability.

The National Defense University's Institute for National Strategic Studies (INSS) is conducting a study that seeks to develop a theory of spacepower– that is, a conceptual framework for explicating the fundamental aspects of spacepower and its relation to the pursuit of national security, economic, informational, and scientific objectives in a fashion that provides insight into the behavior of spacefaring actors. The project takes into account the views and perspectives of the principal users of space, and it attempts to assess the underlying assumptions regarding why and how a society, a nation, or a non-state actor might use space– either alone or, more likely, in tandem with other means– to accomplish specific ends. The resultant theory will provide policy specialists and space professionals from any nation– whether in the national security, civil, or commercial space sectors– with an intellectual foundation upon which to assess the conduct and impact of space-related activities. This paper outlines initial insights generated by the project and serves as a vehicle for eliciting feedback from United States (U.S.) and international stakeholders.

Through a series of seminars, workshops, and conferences, which includes a National Space Forum on the topic held in 2007 that was sponsored by INSS and the Eisenhower Center for Spacer and Defense Studies at the U.S. Air Force Academy, experts in the global space community provided and exchanged a rich set of viewpoints, ideas, and theories in an ongoing dialogue. Additionally, the Spacepower Theory Project team traveled to Japan, China, and India to capture views in a region of burgeoning space competition. The insights in this update will be

refined into a concise monograph for distribution among the space and policy communities.

Additionally, the project team is in the final editing stages of a book length manuscript that was discussed at the National Space Forum mentioned above. The book contains thirty chapters, which are listed below, by various expert authors commissioned for this project. This book will be published by National Defense University Press (or a commercial press) in 2008.

1. Implications of Spacepower for Geopolitics
2. Introduction to Spacepower Theory
3. On the Nature of Theory
4. International Relations Theory and Spacepower
5. Old Thoughts, New Problems: Mahan and the Conception of Spacepower
6. Airpower, Cyberpower, and Spacepower
7. Orbital Terrain and Space Physics
8. Space Law and Governance Structures
9. Building on Previous Spacepower Theory
10. History of Commercial Space Activity and Spacepower
11. Commercial Space Industry and Markets
12. Merchants and Guardians
13. Innovative Approaches to Commercial Space
14. History of Civil Space Activity and Spacepower
15. Affordable and Responsive Space Systems
16. Competing Visions for Exploration
17. Spacepower and the Environment
18. History of Security Space Activity and Spacepower
19. Increasing the Military Uses of Space
20. Preserving Freedom of Action in Space
21. Balancing Security Interests
22. Russia
23. China
24. Europe
25. Emerging Actors
26. Evolving United States Structures
27. U.S. Military Power: Conceptual Underpinnings and Practice
28. Technological Drivers
29. Building Human Capital for Spacepower
30. The Future of Spacepower

These works can only begin to capture a fraction of the thinking in the space community today and should be considered snapshots of progress towards developing a theory. This will not be a definitive work; the theory should be a living document that continues to evolve and progress with the human experience of space. Ultimately, this project is less about space itself, but rather about human, state, and societal behavior and their relationships to the space domain.

Developing a Theory of Spacepower

The overarching scope and definition of this spacepower theory requires a strategic perspective that transcends purely military, economic, political, or nationalistic perspectives. This theory strives to do the following things:

- *Define* what spacepower is, what it is not, and what makes it unique in order to provide a common lexicon for all space actors.
- *Categorize* the elements, constituent parts, and factors that yield a framework for thinking about spacepower.
- *Explain* the ways in which spacepower has exhibited during its short history.
- *Connect* elements within spacepower and to other means of national power.
- *Anticipate* potential ways in which spacepower might be used in the future.

A theory of spacepower should not be confused with a policy, strategy, or doctrine, though it may inform such efforts. Although written primarily from the perspective of the U.S., it is not intended to suggest specific courses of action for the U.S. or any other specific actor. The basic principles of the theory should be applicable across a broad range of space actors.

The development of spacepower theory can be related to the development of sea power theory by Alfred T. Mahan in his work *The Influence of Sea Power Upon History, 1660-1783.*[1] Mahan addressed the importance of economic trade to the

[1]A. T. Mahan, *The Influence of Sea Power Upon History, 1660-1783,* 14th ed., (Boston: Little, Brown, and Company, 1898).

prosperity of the American nation and the implications for maritime and naval activity in the advancement of this prosperity. He addressed the essence of sea power primarily through a historical lens by looking at the nature of the maritime activity of great powers in history. Writing from the perspective of what could be considered a second-tier naval power at the time, i.e., the U.S.; he drew important lessons for creating American economic strength by advancing its attention to sea power. A "Mahanian theory" for spacepower should consider the role of space activity in relation to the larger strategic and international environment.

Spacepower theory, it should be stressed, is not a military theory. It is a strategic theory based upon human activity as applied to the space domain. Although the historical evidence for space activity is limited, theorizing about human behavior in a variety of disciplines provides a sufficient base upon which to draw. Theories of science, philosophy, human nature, politics, economics, and geopolitics have been incorporated in addition to theories of war and other military theories.

A Short History of Spacepower

Since the launch of Sputnik in 1957, the world has seen two identifiable space "ages," each distinct in its significance and influence on human affairs. A much longer pre-space age saw technological advancements enable the fulfillment of once fanciful visions of space travel and exploration. This rich history of space offer signposts that point to potential space ages of the future.

The first space age, from 1957 to 1991, is often associated with the shorthand term "the space race." Space activity became a microcosm of the global geostrategic environment that defined the era. The imperatives of the bi-polar Cold War accelerated the advancement of space technology and activities in space. For both the Soviet Union and the U.S., this competition played out in several important ways:

- A geostrategic competition to showcase technological, economic, and military power.
- A public civil competition to explore near-earth space and ultimately the Moon.
- A (largely) hidden military and intelligence competition for strategic advantage.
- A slowly developing economic enterprise.

The primary commodity of the first space age was prestige. Both the Soviet Union and the U.S. viewed their space programs through the larger geostrategic competition. The prestige associated with the civil space programs afforded a new type of moral power to both nations as they vied to establish dominance of their cultural, political, and economic systems.

Just as the Cold War was the defining context for the first space age, the fall of the Soviet Union and an era of U.S. unipolarity defined the second or "American space age." This space age continues to be the dominant feature of the current space environment. This shift was exemplified by the 1991 Gulf War, sometimes referred to as the "first space war." The predominant features of this space age include:

- The rise of globalization, with greatly increased communications and information flows, enabled by the global perspective of satellite technology.
- A shift in military emphasis from gaining strategic advantage in space to gaining operational and tactical advantage in terrestrial warfare.
- A precipitous decline in the former emphasis on civil space.

The primary commodity of the second space age has been information. While some new players entered the space arena to enhance their prestige, advanced spacefaring actors developed and used space to enable the transition into the "information age." Today's emphasis on information in space has greatly enhanced the military, economic, and political power of those actors, with the U.S. as the dominant power in the space-enabled information area.

It is unclear what the dominant features of the next space age will be or when it will definitively

occur. Shifting features in the geopolitical context suggest that the shift to the next space age will occur within the scope of this theory (i.e., within the next 50 years). These features (to be explored in more detail in an additional section in the final report of this project) include a shift away from the unipolarity of today's international system to a multipolar environment with a much broader and more diverse set of actors. As power is diffused among these actors, the nature of power in space will begin to change. Potential features of the next space age might include:

- Great technological advancements which significantly lower the barriers to entry for potential spacefaring actors.
- Shift from a geocentric perspective to a solar system perspective.
- Renewed strategic competition in space.

A primary commodity of the next space age may well be wealth. The dominant paradigm in space could become an economic one, as activities in space shift from enabling wealth creation on Earth to that of wealth creation in space. The economic value of space is currently but a small fraction of its potential. Beyond the impact space has in supporting earthly economic enterprises, the next space age will be marked by a boom in the economic value of space itself. Alvin and Heidi Toffler have suggested that the development of wealth creation in space would be revolutionary and signify a "fourth wave" of human development.[2]

A brief look at the history of space activity suggests that humans go to space for a variety of reasons: geopolitical, military, economic, scientific, and human destiny. Regardless of the reasons for going to space, such activity conveys a variety of benefits to spacefaring actors: prestige; military advantage; economic competitiveness; and scientific prowess. Benefits accrued to the larger society have included: the advancement of scientific knowledge; stimulation of global economic activity; enhanced communications and information flows; and awareness of the global environment.

The Nature of Spacepower

Power is perhaps the most important yet ill-defined concept in the study of politics and international relations. Power is often associated with the specific instrument through which it is manifested such as economic, diplomatic, informational, economic, or military power. Major dimensions of power focus on how it is created, increased, decreased, stored, communicated, used, and measured. A key consideration is whether power is fungible, or easily transferable, between dissimilar instruments such as diplomatic and military power. Most dimensions of politics and international relations revolve around how states and other actors use power.

This study builds from Joseph Nye's simple definition of power as "the ability to achieve one's purposes or goals."[3] It is therefore a natural extrapolation to define spacepower as "the ability to use space to achieve one's purposes or goals." In a further expansion of the definition of power, Nye suggests that it is the ability to influence others that creates this power. While that is true for spacepower, space capabilities may also be able to influence natural events as well as human behavior. An expanded definition of spacepower could then be derived as "the ability to use space to influence others, events, or the environment to achieve one's purposes or goals."

In an increasingly complex and globalizing society, there are five important types of power:[4]

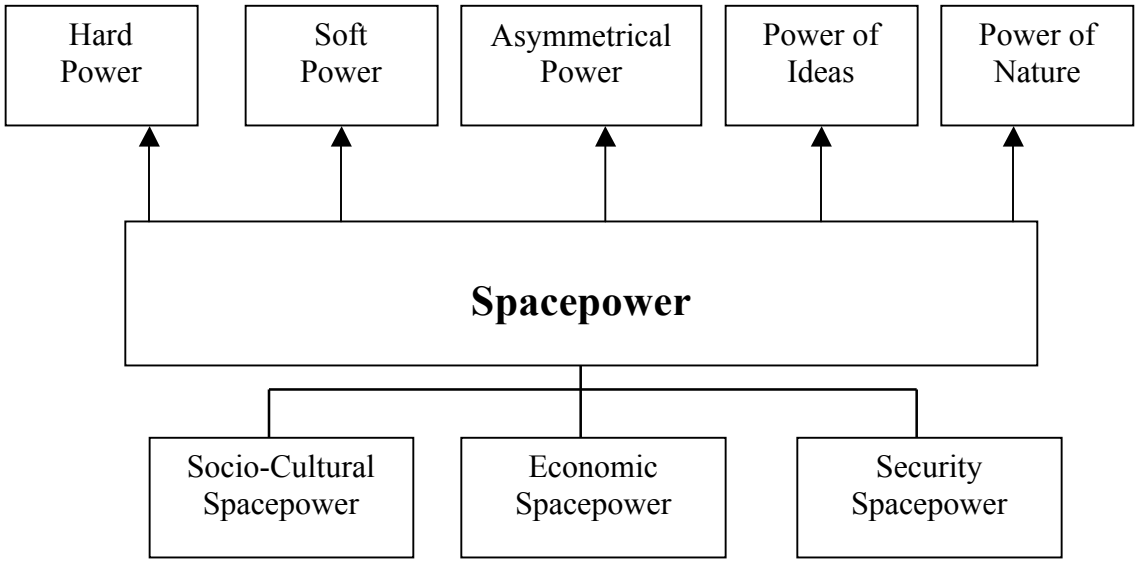
[2]Alvin and Heidi Toffler, *Revolutionary Wealth* (New York: Alred A. Knopf, 2006).

[3]Joseph S. Nye, Jr., *Understanding International Conflicts: An Introduction to Theory and History* (New York: Pearson-Longman, 2005).

[4]See Sean Kay, *Global Security in the Twenty-First Century,* (Lanham, MD: Rowman and Littlefield, 2006). Kay identifies these as state power; soft power; asymmetrical power; people, ideas, and information power; and the power of nature.

- **Hard power.** The classic application of power by state actors consists of the ability to use inducements or coercion through military, economic, or diplomatic applications. Spacepower contributes to an actor's hard power by providing military and intelligence capabilities to threaten an adversary's terrestrial or space-based activities.
- **Soft power.** This concerns the overall attractiveness of an actor to others to attain its goals without threats or use of force. This "attractive power" is attained by setting the example and getting others to emulate favorable behavior. Spacepower provides prestige, technical and educational prowess, economic incentives, and cooperative ventures as means for enhancing soft power.
- **Asymmetrical power.** The acceleration of globalization has created a diffusion of power that allows weak actors to challenge strong or dominate actors in asymmetric ways. Spacepower tends to be dominated by stronger actors, but can be threatened asymmetrically by weaker actors through means such as kinetic anti-satellite weapons (ASATs), jamming, or attacks on ground facilities.
- **Power of ideas.** The diffusion of power from states down to the individual has occurred through the ubiquitous availability of information and ideas. Such power can either weaken or strengthen a state, society, or political system depending on the context. Spacepower plays a great role in the transmission of this type of power through communication, remote sensing, and navigation applications.
- **Power of nature.** Nature itself wields power that can present security challenges. The power of humankind to mitigate or avoid the ravages due to natural disasters, pandemics, climate change, or collision by near-Earth objects is enhanced by spacepower capabilities.

Spacepower contributes to all of these forms of power, including sociocultural power, economic power, and security power (see Figure below).



Definitions

Developing and applying a comprehensive and consistent set of definitions and categories are essential steps towards building spacepower theory. In addition to the discussion of power and spacepower above, key terms for this study include:

- **Space.** There is no universally accepted definition of space or outer space. Disputes

over sovereignty, the inability to precisely describe a spatial demarcation, need to distinguish from laws regarding airspace and other legal issues have stymied the development of an accepted definition. There has been a sort customary law that has developed to the effect that any object in orbit is considered to be in space.[5] For the purposes of this study space begins when objects are able to achieve positions in stable orbits around the Earth or beyond. With current technology, this would describe space as beginning at an altitude of approximately 69 miles (and above the accepted end of aerodynamic limits, the von Karman jurisdiction line, which is approximately 55-62 miles in altitude).

Astrographic. Everett Dolman provides a useful astrographic delineation of space into four regions: (1) terra (Earth and space to a point just below sustained, unpowered orbit); (2) terran space (lowest viable orbit to just beyond geostationary altitude); (3) lunar space (just beyond geostationary orbit to just beyond lunar orbit); and (4) solar space (everything else in the solar system).[6]

- **Spacefaring.** Spacefaring is "the ability to do something in space." Spacefaring activities are "activities conducted in space." Spacefaring actors are "state and non-state actors engaged in spacefaring." Spacefaring actors conduct spacefaring activities through indigenous production, collaborative efforts, or third party purchase of space systems or services.
- **Space Industrial Base.** The space industrial base includes "those elements of industry and education that contribute to spacefaring."

Shaping Factors

An actor's spacepower capability is shaped by in variety of ways. The physical nature of the domain both constrains and enables human ability to utilize space for specific applications. Technology is used to overcome these limitations but is itself constrained by costs and the state of scientific development. The appropriate resources to include wealth, access to materials, and industrial capacity are essential. The political and cultural environments within and among nations also determine the level of interest and motivations for developing space programs. Finally, governance issues, particularly with regard to international laws and regimes, play a role in determining the path of spacepower. In considering these shaping factors, some implications can be derived:

Spacepower is unique because it can operate both in relation to earth activity and independent of it.

- Certain physical phenomena in space (e.g., gravity wells, libration points, predictable Earth orbits) can provide strategic advantage (and disadvantage) to space powers.
- Technology eventually lowers costs.
- Space technology can be single or multi-use.
- Maintaining the space infrastructure and an industrial base is not a free good.
- Political will is required for the long haul.
- Non-state actors may be hampered by domestic regulations, laws, and political constraints.
- A spacefaring culture includes both technical prowess and ambition.

Forms of Spacepower

Almost all space activities can normally be placed into just one of the following sectors: civil, commercial, military, or intelligence activities. However, growth in commercial space activity, the increasing number of dual-use space systems, and digital convergence can also make it increasingly difficult to categorize certain space activities neatly into one of these sectors. Many spacefaring actors have separate government organizations dedicated primarily to performing only the activities within one of these sectors. For the purposes of this study, the military and

[5]Glen H. Reynolds and Robert P. Merges, *Outer Space: Problems of Law and Policy,* (Boulder, CO: Westview Press, 1998).

[6]Everett C. Dolman, *Astropolitik: Classical Geopolitics in the Space Age*, (London: Frank Cass Publishers, 2002).

intelligence activities will be considered as a single sector, the national security space sector.

Spacefaring actors include those operating at the surprastate, transnational, state, and substate levels. This raises a "levels of analysis" problem that makes consistent categorization and comparisons difficult. By considering an actor's level of activity across the three spacepower sectors described in the previous section, a set of archetype space actors can be fairly described as follows:

- Comprehensive space powers have robust, indigenous space capabilities that provide significant benefits through space operations in all space activity sectors: commercial, civil, and security. They have indigenous capacity to manufacture, launch, and operate space systems.
- Emerging space powers are those actors actively developing their capabilities in all three sectors of space activity. They may still be developing capacity in certain areas, but are progressing toward comprehensive capability.
- Niche spacefaring actors have chosen not to develop comprehensive space capabilities or do not (yet) have the intent or resources or required to develop such capabilities.
- Consortia, such as the European Space Agency (ESA) or the partners in the ongoing International Space Station (ISS) effort undertake many space activities.
- Space entrepreneurs are pursuing a range of new private space ventures such as space tourism or space mining activity.
- Free riders are space beneficiaries that use at least some product or service created by spacefaring activity. Due to growth in the efficacy and ubiquity of spacefaring activity, these space beneficiaries comprise a very broad category that includes nearly every actor in the modern world.

In describing spacepower, the unique aspects of space as an operating environment and of spacefaring activity as a set of human endeavors are evident. A few insights from this section include:

- Metaphors from other domains, sea, air, and land, do not necessarily apply.
- Perspectives and motivations vary among actors, categories of actors, and among sectors. Consider the primary drivers in each of the space sectors: civil space as destiny and discovery driven; commercial space that is profit driven; and security space, which is threat driven.
- Harmonization among space actors, categories of actors, and among sectors is difficult to achieve.

Spacepower and the International System

Spacepower has an emerging role in the international political system, and at the same time the nature of that system influences how actors might perceive and use spacepower. Spacepower to date was shaped primarily by the Cold War context in which it matured. As the international system exhibits changes over the next fifty years, the nature of spacepower can be expected to change with it.

Realist and Liberal Perspectives

Associating the word power with space activity connotes in many a realist interpretation of human behavior, yet both the realist and liberal perspectives are present in those advocating and developing spacepower strategies. It is useful to consider varying assumptions that might affect an actor's notion about the role of spacepower in the international system. The table below briefly highlights some of these assumptions and prescriptions generally associated with traditional realist and liberal perspectives.[7]

[7]This chart was derived from a number of sources. See John J. Mearsheimer, *The Tragedy of Great Power Politics,* (New York: W.W. Norton, 2001); Joseph S. Nye, Jr., *Understanding International Conflicts: An Introduction to Theory and History* (New York: Pearson-Longman, 2005); Hans Binnendijk and Richard Kugler, *Seeing the*

While certainly there are more complex explanations of the international system, this simplistic look at the two major perspectives goes a long way to understanding the tension points in many spacepower debates. The realist would tend to view space as another domain for great power competition, and ultimately conflict. The liberal view in its most progressive form sees space as a venue for the evolution of the human species to a higher order destiny; but at a minimum holds that maintaining space as a sanctuary provides the best guarantee of stability in space.

	Realism	**Liberalism**
Assumptions about human behavior:	Pessimistic	Optimistic
Unit of analysis:	Individual states	International system
Principal actors in international system:	States exclusively; great power states primarily	States primarily, but increasingly diverse set of supra- and sub-national actors
State behavior determined by:	External power calculations	Internal characteristics
Modern world affairs driven mainly by:	Security competition	Democratization and economic growth
The main goals of foreign policy should be:	Increasing power to guarantee security and survival	Democracy and economic growth
The primary instrument is:	Hard power	Soft power
Concerned with:	Relative gain (zero-sum)	Absolute gain (mutual benefits)
International system should be optimized to provide:	Security	Stability
Treaties, alliances, and international institutions merit:	Less faith	Strong support
Interdependence creates:	Vulnerabilities	Opportunities for cooperation
Best chances of success in world affairs comes from:	Benign hegemony by a great power acting as a Leviathan	Liberal democracies working together multilaterally

Elephant: The U.S. Role in Global Security, (Washington, DC: Potomac Books, 2006); and Sean Kay, *Global Security in the Twenty-First Century,* (Lanham, MD: Rowman and Littlefield, 2006).

These competing viewpoints vie for influence in the decision processes of spacepower actors. Applying the realist and liberal lenses to spacepower yields the following insights shown in the next table.

	Realism	Liberalism
Human behavior in space:	Will mirror human behavior on Earth	Can transcend terrestrial disputes
Principal actors in space:	Spacefaring states	Spacefaring states; consortia; non-state entities; private enterprise
State behavior in space determined by:	Power calculations	Domestic goals and needs
Spacepower optimized for:	Security	Stability
Spacepower is maximized through:	Space dominance	Space as a sanctuary
Space as a venue is inherently:	Competitive	Cooperative
Rules sets should guarantee:	Freedom of access	Common heritage of mankind; peaceful uses of outer space
Means to achieve:	Space control	Legal frameworks
Interdependence in space creates:	Vulnerabilities; cascading effects	Opportunities for cooperation; stability

The Current Paradigm of Spacepower in the International System

The 1967 Outer Space Treaty defined the initial principles for space activity and these principles describe the dominant paradigm of the international community regarding spacepower:[8]

- Space is the province of all mankind– a "global commons."
- Space is to be used for peaceful purposes.
- All states have an equal right to explore and use space.
- International cooperation and consultation are essential.
- Signatories retain ownership of their space objects and bear responsibility for their space activities, including and damage inflicted on another state's space objects.

Although most, if not all, spacefaring actors ascribe to the principles of the Outer Space Treaty, a number of issues have arisen to challenge the dominant paradigm:

- **Definitional problems.** The terms "peaceful uses" and "common heritage of mankind" have widely varying interpretations among space actors.
- **Sovereignty and property rights.** Economic development in space under the current paradigm is stunted by lack of legal definition concerning these issues.
- **Prospects of weapons in space.** Concerns over possible deployments of ASATs and space-based missile defense systems present serious problems for those desiring space to retain a "weapons-free" status.
- **Pursuit of self-interests.** As more actors enter into the space domain, there may be a growing

[8] *Treaty on principles governing the activities of states in the exploration and use of outer space, including the moon and other celestial bodies*. Done at Washington, London, and Moscow 27 January 1967; entered into force October 10, 1967.

tendency to pursue unilateral interests rather than adhere to established norms.

International Security in Space

The space political environment is still in its infancy, and it is unclear how the balance between purely national and global interests will be managed. A reframing of the current paradigm may be required to accommodate the changing nature of space activity. States will likely seek alternative arrangements in space as they perceive greater security vulnerability. Some alternative ways that states may choose to enhance security or stability, either individually or collectively, include:

- Pursue unilateral strategies.
- Apply a balance of power approach.
- Develop alliance-based security arrangements.
- Establish "rules of the road."
- Establish frameworks for cooperation and interdependence in space.
- Negotiate arms control or other legal restraints.

From the standpoint of international security, one can identify an optimal condition of enduring stability in the space domain. Its attributes would include:

- A norm of unfettered access to space as a feature of amicable inter-state relations.
- A solid measure of protection, through individual or collective measures, against the aggressive or capricious acts of spoilers.
- A situation in which the real or perceived vulnerabilities among space actors are minimized.

Ultimately, creating a condition of enduring stability in outer space will hinge upon how tensions between national interests are addressed and whether there emerges over time a convergent perception of what actions tend, on balance, to strengthen or undermine stability. If enduring stability is not the primary goal of major space powers, then the prospects for military competition and conflict will increase.

Enhancing the International System

In a stable environment, space can enhance and strengthen the international system. The economic and sociocultural imperatives discussed earlier suggest the importance of maintaining space as a domain for wealth creation and for solving problems of humankind. Spacefaring actors should consider adopting cooperative approaches in space to address some of issues of global concern:

- Energy scarcity.
- Global climate change.
- Space situational awareness.
- Space debris.
- Defense against Earth colliding objects.
- Material resource scarcity.
- Extra-terrestrial property regimes.

The ability to forge collective action on these and other issues will enhance understanding, confidence building, and sharing of knowledge that will contribute to the stability of space as a regime and to its effectiveness in enhancing human prosperity.

Sociocultural Spacepower

Space has been described as a "global commons," a term which suggests a medium or domain that exists for the common good of all. Global commons are "natural assets outside national jurisdiction, such as the oceans, outer space, and the Antarctic."[9] There is no international standard as to what constitutes a global commons, and consideration of such varies widely. In addition to the oceans, outer space, and the Antarctic, some areas that are considered include: the atmosphere, telecommunications (electromagnetic spectrum), information, culture, and the environment. The idea that space would remain a province for cooperation is based on two interrelated principles that have been established as international norms:

[9] *Glossary of Environment Statistics, Studies in Methods*, Series F, No. 67, (New York: United Nations, 1997), stats.oecd.org/glossary/detail.asp?ID=1120 (accessed 4 August 2007).

(1) the peaceful purposes of outer space; and (2) the "common heritage of mankind" (CHM). The terms "peaceful purposes" and "common heritage of mankind" set forth social expectations that space should be used for the common good.

The public persona that satisfies these socio-cultural expectations can be found in the civil space activities of space exploration and space sciences. For current and emerging space superpowers, its "space program" in the public eye will be synonymous with its ability to explore beyond the Earth and unlock the secrets of the universe. Such a capability proves a state's technological prowess and single-minded ability to achieve its lofty goals. Indeed, becoming a space superpower is about vying for superpower status on the larger stage. Two general principles can be derived from the limited history of civil space activities:

- Prestige is the primary motivation for developing a civil space program.
- Spacefaring societies seek to extend their cultural values into space.

Civil space activities can be categorized into four main areas of current or future emphasis: (1) space exploration; (2) space science; (3) environmental security (both Earth and space environments); and (4) human habitation. In looking at these areas, the following can be derived:

- Space exploration attracts states and societies that have expansionist traditions, expansionist aspirations or both.
- Space science is a strategic asset in that it ensures technological independence cultural identity, supports a science-based society, and demonstrates capability and vision.
- Space provides an opportunity to solve common global problems through common global solution.
- Space settlements may one day be the key to the survival of the species.

Civil space activities must balance supporting national interests while advancing global interests. Of all the sectors, civil space activities are most likely to be cooperative in nature to achieve the goals of such programs, yet the programs themselves are subordinate to an actor's broader goals.

Economic Spacepower

Spacepower both influences and is influenced by an actor's economic power. Space applications have enabled globalization, created opportunities for development, and enhanced the global nature of the economy. In its current state, spacepower enables other economic enterprises. The potential for creating wealth from space suggests the likelihood of expanding development and economic competition at some point in the future. The point at which that potential is realized is greatly dependent on the factors that shape spacepower.

Spacepower has been a major, if often underappreciated, factor in enabling the globalization trend of the last twenty years. The explosion in communication and information technology was made possible through the global view of Earth-orbiting satellites. For developing areas of the world, space assets offer ways to better manage natural resources and extend services to remote populations. Additionally, space applications have played a major role in economic development.

- Telecommunications from space can be used to collect or distribute information from dispersed territorial entities.
- Space-based navigation facilitates the management of global fleets enabling the rapid movement of goods world-wide.
- Earth observation and remote sensing play a role in the design and implementation of new land infrastructure, the management of crops and natural resources, the enforcement of agricultural policy and environmental treaties, and the mitigation of natural disasters.
- Meteorological satellites greatly improve forecasting and monitoring of extreme weather conditions and the ability to mitigate their effects.

The Commercial Space Industry

The commercial space industry includes both an upstream segment, which includes manufacturers of space hardware and providers of launch services, and a downstream segment of satellite operators and providers of space-enabled products and services. Currently, the commercial space industry is focused almost exclusively from Earth-orbiting applications. The key characteristics of space-based activities that bear on the commercial space industry include: high risk; high-cost research and development; complexity of new technologies; economies of scope; dual-use nature of the technology; long gestation and durability of space assets; long value-added chain; and economies of scale downstream.[10]

The current economic paradigm is to use satellite technology to create wealth from space. Space service include: satellite telecommunications; satellite subscription and retail services; interactive broadband; global positioning, navigation, and timing (PNT); and commercial Earth observation.

The future economic paradigm will be to create wealth in space. Additionally, economic enterprises will not be limited to Earth's orbital plane. Eventually, wealth creation will occur on other planets and celestial bodies as well as in deep space. The timing of such activity is again dependent on the set of interrelated shaping factors. Some of the applications likely to create wealth in space over the next fifty years include: space tourism and adventure (orbital and sub-orbital flights); in-orbit servicing; space manufacturing (e.g., pharmaceutical products and new materials developed in microgravity); energy from space. (e.g., space based solar power systems to provide Energy to Earth.); and extraterrestrial mining. (e.g., mines on the Moon to harvest Helium-3 or mining near Earth objects for minerals). The ability to develop these markets depends requires:

- Significantly reduced access costs.
- Favorable economic environment.
- Safety and security of space assets and humans in space.

A robust and vibrant space economy is highly dependent on a number of factors. A review of those factors yields the following insights:

- The economic paradigm will eventually shift from creating wealth from space to creating wealth in space. New markets will develop that could radically alter the outlook for economic development in space.
- Technology is the most significant factor shaping the commercial space industry. Radical technological improvements, particularly in space access, will produce profound changes in what can or cannot be accomplished in space.
- The high costs of current space activity require heavy research and development efforts and assumption of risks beyond the scope of most space entrepreneurs. Sustained involvement of governments will be required to mitigate this risk in the near term.
- From an economic perspective, space should be a domain free to the pursuit of economic goals. The economic "global commons" approach is viewed differently from the sociocultural context that suggests all development benefits should be shared.
- Stability of the space-enabled information infrastructure is essential to continued global economic growth and vitality. Conflict, or the threat of conflict, would have serious effects on information flows vital to the global economy.

Security Spacepower

Notions of security in space (and through space) vary markedly based on the perspectives of diverse actors, a broad range of challenges and threats, and the nature of various space activities themselves. Space activities enable economic

[10]Organization for Economic Co-Operation and Development (OECD), *Space 2030: Exploring the Future of Space Applications,* (Paris: OECD, 2004).

security by enhancing the value of global economic interdependency, while reducing the vulnerabilities of singular actors. Human security can be advanced through such activities as: space-based telemedicine; infectious disease control; and enabling expansion of economic development in rural areas or those areas previously inaccessible to basic services. Environmental security can be enhanced through global monitoring of the Earth and solar system. Energy security may be achieved by those that are able to tap into a potentially unlimited source of solar and other forms of power in space.

While space has a role in each of these security areas, spacepower is often thought of in the context of national security as it enhances the ability of spacefaring nations to compete and thrive in an anarchic international security environment. The use of the terms "power" and "spacepower" are most closely associated with the notion of power as accorded to the state. While there clearly are many other forms of power wielded by many different types of actors in and through space, this project assumes that the state will remain the dominant form of power broker for the foreseeable future. Thus, it is important to consider the how spacepower relates to national security.

States and other actors tend to focus on pursuing their own interests. Space capabilities enhance the ability of an actor to gain economic, political, or military power relative to those that do not possess spacepower. Space confers strategic, operational, and tactical advantages because it provides a global view of the terrestrial environment in which competition and conflict currently takes place. In the future, space actors may seek to control key "geographic" regions of space (e.g., libration points, lunar antipodal points, preferred earth/lunar orbits) to gain strategic advantage for exploiting resources or establishing space lines of communication.

Depending upon how it perceives its national interests, a space power may pursue security in several basic ways: it may seek to maintain a favorable status quo; it may seek to expand its power to increase or close a perceived gap relative to other space powers; or it may seek to limit or constrain the power of other space actors. A spacefaring state will have two main concerns with regard to security and its space capabilities: (1) how to use space capabilities to provide for, support, and enhance the overall security of the state or related actors (security through space); and (2) maintaining the security of space capabilities themselves, both military and non-military (security in space).

Space is an operationally distinct medium. Spacepower, however, is not strategically distinct; it is part and parcel of an actor's ability to influence human (and perhaps natural) events regardless of where they occur. Spacepower may provide strategic advantage on earth or in space.

Security through space implies the use of space assets to enhance the security posture of an actor or set of actors on Earth. Space capabilities may be used by an actor to prevent conflict and ensure stability through:

- **Transparency.** The ability to "see" capabilities as they are developed and events as they unfold reduces uncertainty and provides strategic warning.
- **Deterrence.** The space-based reconnaissance complex plays an important role in providing warning as well as command and control for nuclear forces.

Conversely, a state may use its space assets to enhance terrestrial warfighting capability through:

- **Force enhancement.** Space forces greatly enhance the capability of air, land, and sea forces through PNT, command and control, and intelligence, surveillance, and reconnaissance (ISR).
- **Force application.** In the future, actors may develop ways to apply force directly from space to generate combat effects on the terrestrial battlefield. Defenses may also be deployed in space to deter and protect against ballistic missile attacks.

Security in space concerns the protection of space assets themselves, whether used for military or civilian purposes. States, particularly those with strategic advantage, will seek to maximize their freedom of action in space. In order to do so, an actor may seek capabilities in the following areas:

Transparency. Space situational awareness (SSA) is essential to identifying potential threats in space. Equally important is transparency over potential adversaries ground based activity as it relates to space.

Protection. The fragile and vulnerable nature of space assets, particularly commercial and civil assets, suggests that protection measures be considered early in the design cycle of space systems. Military forces may be called upon to protect civilian assets.

- **Denial.** The ability to negate adversary space capabilities, through such means as ASAT programs, may permanently or temporarily shift advantage in space.
- **Space control.** Space control is a combination of protection and denial strategies. An actor desiring freedom of action in space may also wish to limit its adversary's freedom of action to remove a perceived threat. This requires maximizing both protection and negation capabilities (e.g., defensive and offensive counterspace).

A number of security challenges and dilemmas arise as actors pursue individual interests in space:

- **Space assets are fragile and vulnerable.** Should space become a contested environment? The fragility and vulnerability of space systems make them attractive targets and complicates the ability to defend in space.
- **The lines between civilian and military space assets become blurred.** Systems deployed in space have the ability to be used for more than one purpose. Commercial communications satellites carry a large portion of military communications and can become vulnerable to attack in a conflict scenario.
- **Capabilities designed to enhance security through space may reduce security in space, and vice versa.** For example, space-based missile defenses may enhance protection against ballistic missiles, but they themselves become a strategic target and open the possibility for conflict in space.
- **Achieving the economic and sociocultural potential of space requires enduring stability in the domain.** Individual or unilateral strategies to expand power, limit adversaries' power, or maintain freedom of action in space may threaten overall stability of the system.

Spacefaring states will pursue security strategies in space based on their degree of reliance on space capabilities, perceived vulnerabilities both in and from space, and the perceived behavior of other actors. The following behavioral models may be observed as actors seek to meet their security needs in space:

- **Space dominator.** A domination strategy can only be attempted by a comprehensive spacepower with a highly advance military capability. A space dominator is likely to be highly reliant on spacepower to achieve its objectives in both in space and on Earth, and at the same time may feel a certain amount of insecurity due to the vulnerability and fragility of its space assets. Such a strategy would seek to increase its relative power vis-à-vis other space actors to enable freedom of action to pursue its interests in and through space. The dominator sees space as the ultimate high ground, and perceives a strategic advantage to dominating certain key regions of space, either for military or economic advantage. Such an actor would also seek to deny any competitor access to these areas or other areas that would diminish the dominator's relative advantage. The risks associated with such a strategy include high cost of pursuing technologies, miscalculation, potential for arms race, and asymmetric responses by other actors. Space dominators would feel challenged by another space dominator, constrainers, or spoilers.

- **Space protector.** Space protection is an alternate strategy that might be employed by a highly reliant, highly vulnerable space power. The aim of the protector differs in that it seeks only to protect its ability to benefit from space without regard to other actors. In other words, the protector seeks to maximize the absolute benefit it derives from space without concern of relative gain over others. A protection strategy would maximize capabilities such as: SSA; passive or active satellite protection; and operationally responsive space. At the same time, this strategy risks providing a window of opportunity to a competitor to advance its position relative to the protector. A protector would feel threatened by a space dominator or a spoiler, or an actor moving to one of those strategies.
- **Constrainer.** An actor with more limited space capabilities might adopt a constraining strategy to limit relative gains by other actors. A constrainer would likely be less reliant on space than a more comprehensive space power, but may feel threatened by increasing gains by others. Arms control and legal restrictions are favored in this type of strategy as they are used to constrain the power of other actors. The object of this constraining behavior is likely to be a perceived space dominator or a possible spoiler that develops asymmetric capabilities. While attempting to constrain certain actors, this strategy might inadvertently allow other actors to gain primacy.
- **Spoiler.** Like a constrainer, a spoiler may be at a relative disadvantage with regard to other space actors, but this disadvantage is likely to be more strategically significant, particularly in times of crisis or war against a comprehensive space power. A spoiler would seek to employ asymmetric power, such as an ASAT capability to mitigate this vulnerability. Spoilers are most likely to arise in reaction to a space dominator or protector. The spoiler risks miscalculating the response of its object and may find itself as the target of retaliation.
- **Collaborator.** A collaborative strategy may be employed by an actor who does not feel a direct threat from the space capabilities of other actors, and wants to avoid direct security competition in the future. It will seek to protect its absolute gains in space through collective security arrangements and collaboration in other areas. The collaborator seeks interdependence with other space actors to avoid conflict. It may align with a dominator, protector, or constrainer and may feel threatened by a different dominator or spoiler.
- **Free rider.** Free riders seek to minimize their security profile and depend on the protection of the system or of others. They tend not to be in direct competition with other security actors and seek to maximize the absolute benefits they derive from their space activities.

Ideally, stability is best achieved when all actors pursue strategies that seek only absolute gains from their space activity, rather than relative gains in power vis-à-vis other space actors. Protectors, collaborators, and free riders are compatible with mutual gains by other actors. Dominators, constrainers, and spoilers look to enhance their own spacepower or constrain or deny the power of others and therefore, cause more perturbations in the system. The more asymmetry that is introduced among actors, the more unstable the situation. For instance, two dominators in the system may create security problems for each other, but may create a stable system as each one checks the other. Nonetheless, a dominator challenged by a spoiler can lead to conflict as a spoiler sees a narrow window of opportunity for courses of action. Moreover, as perceived security needs change, so will the strategies employed. As one actor perceives a change by another actor, it is likely to adapt if that change creates more vulnerability or offers new opportunities to gain relative advantage.

Summary

The development of spacepower theory is an ongoing process. As the world develops new technologies, employs new ways of using space, and develops new frameworks for regulating it, the impact of space will continue to evolve. Spacepower theory provides the opportunity to

influence this process in a way that maximizes the benefits of space for the global society. The future of humankind will be written by the thought and action of society as it ventures into the universe.

Summer Space Seminar 2007

Eisenhower Center for Space and Defense Studies
Space Policy Institute, George Washington University

Colorado and Washington, DC, May – June 2007

The Summer Space Seminar 2007 proffered two principal goals: (1) to foster an education and interest in the interdisciplinary areas of space with the intent to develop space professionals now or in the future; and (2) to develop a network of relations across future civil, commercial, and military space professionals that will likely emerge from the participants in the Seminar.

In regard to the first goal, the Seminar exposed participants to the breadth and depth of space activities in the civil, military, and commercial areas. The seminar covered a number of topics: (1) space technology, space physics, space weather, planetary sciences, space law, space policy, space management, space history, space economics, and human space exploration in the civil area; (2) national security space, including the role of space in bringing effects to the warfighter, Air Force space professional development, Air Force space history, and space power in the military area; and (3) space commercial development in the satellite and space launch industries. The relationships among these topics were explored across a number of perspectives. To illustrate, participants were first exposed to the technology and science of space activities, followed by discussions on the political, legal, economic, and social aspects that influence the development and application of the various civil, commercial, military space activities.

The Seminar was successful in recruiting a diverse set of participants. The program brought together students from the United States (U.S.) Air Force Academy, U.S. Naval Academy, U.S. Military Academy, George Washington University, and the Massachusetts Institute of Technology helping to lay a foundation for a future space policy community in the military, civilian government, and private sectors.

For some in the group the seminar was their first exposure to the role and importance of space, for others it exposed them to other areas that affect space beyond technology and science like policy, law, and economics, and for others it served as useful forum for further professional development given that several of the participants worked, or are currently employed, as space professionals. Given this diversity among participants, a great deal of learning and socialization took place among the group that will serve to meet the second goal in future years.

Northrop Grumman has agreed to support a 2nd Summer Space Seminar planned for May 2008.

Ambassador Roger Harrison and Dr. Eligar Sadeh
Eisenhower Center for Space and Defense Studies

China Working Group: China, Space, and Strategy

Eisenhower Center for Space and Defense Studies
School of Advanced Air and Space Studies, Air University

Keystone, Colorado, June 2007

Chinese advances in its space program in recent years has led to a growing international interest in the implications of Chinese programs in the civil, military, and commercial space sectors. This workshop, sponsored by the United States (U.S.) Air Force Academy Eisenhower Center for Space and Defense Studies and the Air University School of Advanced Air and Space Studies, brought together a community of experts and policy-makers to discuss the implications of current and future Chinese space developments on space policy and law, in particular the Chinese anti-satellite (ASAT) test conducted in January 2007.

Thirty-five individuals attended the workshop, including, among others, Major General Armor of the National Security Space Office, Dick Buenneke of the State Department (State), Tom Reich representing the East Asia Bureau of State, Hong Yuan of the Center for Arms Control and Nonproliferation Studies in Beijing, Wu Chunsi of the Shanghai Institute for International Studies, Dean Cheng of the Office of Naval Analysis, who acted as a translator when need for the Chinese nationals, and representatives from Europe, aerospace companies like Lockheed Martin, and leading academic scholars and consultants in space policy and space law. The one-day workshop focused on both military and commercial aspects of the U.S.-Chinese relationship in space. It was conducted under Chatham House rules, which forbid citing specific comments made by the participants.

In general, it was my impression from the statements made during the day, as I said in my summation at the end of the session, that the U.S. side was leaning well forward, ready to engage more actively at any sign that the Chinese were willing to be forthcoming. There was little to sign of a positive response from the Chinese side, although there was a statement to the effect that, in the "opinion" of the speaker, there will be no further ASAT tests of any kind, at least through 2012. It is safe to say that U.S. officials at the meeting were skeptical about this assurance.

Of note, was the revelation that the Chinese scholars viewed U.S. actions the past decade with much suspicion and even threatening to China's national interests. In this regard, the Chinese nationals directly pointed to the U.S. unwillingness to cooperate with the Chinese in civil and commercial space, U.S. actions like the "inadvertent" bombing of the Chinese embassy during the war in Kosovo, and the emerging doctrine of counterspace operations in the U.S. that is also reflected in the 2006 Bush national space policy. It was mentioned by the Chinese scholars that these events encouraged the Chinese to undertake a path to developing comprehensive space power capabilities. The ASAT test of January 2007 conducted by the Chinese was viewed internally as routine test along this path

The Chinese scholars also emphasized the importance of language. For example, the talk of "transparency," which is an important idea that U.S. officials stress to the Chinese, as the word is translated into Mandarin, has overtones of espionage, and therefore, would not elicit a positive response. This pointed to the need for more involvement by Chinese linguists in formulating our policy statements on China space; one term suggested at the workshop was "clarity of intent."

On the question of Chinese decision-making, the Chinese nationals emphasized that the Peoples Liberation Army (PLA) and the Ministry of Foreign Affairs (MFA) reported up separate communication channels to the Supreme Council and that there was no direct communication between the two entities. Further, the thinking among the Chinese scholars was that the PLA is quite insular and there was not enough attention paid to the international implications of the Chinese ASAT test. The implication is that the test is not something that the MFA would likely not have suggested.

There seemed as well to be a consensus that the U.S. reaction to the ASAT test had been relatively moderate, that the US was ready for more dialogue, and that by "transparency" in our policy statements what seemed to be meant was a desire for more clarity of intent in space on the part of the Chinese. In my conversations with Mr. Yuan, I suggested that as a gesture of goodwill the Chinese might want to host a similar Space Working Group meeting next year. He responded that it would be a useless exercise, since the Chinese participants would not dare to speak frankly at such a meeting. Finally, the America military participants emphasized that they had a policy directive in the Bush Space Policy to push for greater engagement, including with the Chinese, on space issues, and that this is what they intended to do.

The Chinese scholars conveyed that it is in fact the Chinese willingness to demonstrate space power that creates opportunities for dialogue with the U.S. The key is that the U.S. does not, and thus needs to, view China as a "legitimate" power. Moreover, the Chinese nationals stated that China desires to be a responsible player in world affairs.

This workshop was second annual China Working Group meeting and the first to include Chinese nationals and the U.S. State Department. The meeting represents a possible channel for discussions, what is being called by State Track 1.5 as distinct from Track 2. It also strengthened the Eisenhower Center's working relationship with State, our contacts in China and with the Chinese community, and our relationships among scholars and think-tanks.

Ambassador Roger Harrison and Dr. Eligar Sadeh
Eisenhower Center for Space and Defense Studies

Future of Space Commerce Workshop: Reducing Risks and Fostering Partnerships – Synergies between Civil, Military, Commercial, and New Space

Eisenhower Center for Space and Defense Studies
Futron Corporation
NASA Ames Research Center

Breckenridge, Colorado, August 2007

The Future of Space Commerce Workshop brought together participants from the civil, military, commercial, and new space sectors, and relevant academic, consulting, business, and financial organizations to discuss and explore how risks associated with space commerce development can be reduced, and to examine synergies to strengthen and advance partnerships between the sectors. The workshop was hosted by the United States (U.S.) Air Force Academy Eisenhower Center for Space and Defense Studies in cooperation with Futron Corporation and NASA Ames Research Center.

A number of topics were addressed at the workshop. These topics included: availability of private money and finance; government and private sector technology drivers; political and legal framework; and environment. The session on private money and finance addressed a number of issues that ranged from: business planning, capital markets, government contracting, venture capital, "angel" investors, realistic return on investment, markets for products and services, cost or affordability, government procurement or purchasing of commercial services, prizes for technology innovation, subsidies, tax benefits and credits, loans, and government corporate ownership models.

The technology drivers part of the workshop focused on technology transfer, heritage systems, low cost technical innovation, in-house expertise, contracting-out issues, technical personnel and workforce, and reliability and responsiveness of technical systems. Following this session, the one on politics and law looked at safety regulations, licensing processes, export controls, transfer of intellectual property rights, and patent protection. Finally, the session on the environment examined issues related to space commerce and space situational awareness, space traffic management, and orbital debris.

Summary of the Discussions

- There is growing dependence between the different space sectors- civil, military, and commercial. Space in many ways is at a cross-road in all these sectors. The key issue is how to move forward into a "new" space age driven by space commercial activity (see Addendum 1). There is a strong case to be made that space is in the national security interests, but a much weaker case is to be made that space is in our national economic interests. In the U.S. national security trumps commercial space leading to policies, like export controls, that undermine space commercial development. In addition, there is little understanding of the pervasiveness of space in many commercial activities and transactions.
- Of concern to fostering such a new space age, is to shift the paradigm on how humans view space. This shift needs to better consider human-space/space-terrestrial connections that will drive space commercial activity.
- A key question to address is why invest in commercial space? Clearly, there are markets, but the ideas need to be accessible and realistic as to ROI considerations. The key issue with commercial space is not technical risk per say (though single point failure problems can be an issue for space launch in particular), but the issue of financing and ROI.
- The issue of risk cuts across a number of factors from technical ones related to development and innovation, political and legal ones largely concerning the regulatory environment, and business and market risks. Space commerce is

characterized by a misallocation of risk versus reward (as in ROI). There is also less tolerance for risk as it is in many ways being "regulated" out of the way of doing business.

- There needs to be some attention toward developing possible "disruptive" technologies that could dramatically change the space commerce paradigm. "Experimentation" in space in such areas as smallsats and partnerships with both private space companies and non-space companies is important in this regard. NASA is interested in fostering private space commerce. Examples include: the NASA COTS program, Space Act Agreements with New Space companies, and non-space partnerships with Goggle, Microsoft, Sun, and Biotech firms.
- Much of the success in commercial space exists in the Satcom sector where the many of the key players are not seen or perceived as "space" companies. The fact is that many industries are enabled by space assets. Value-added services making use of remote sensing and GPS data are important examples. There are rapidly growing markets that will continue to consume such services.
- There are a number of constraints on the emergence of this new space age. This includes: issues of innovation as many programs and projects are locked into funding and acquisition patterns that cannot be easily changed or modified; the lack of political and public support for many space initiatives due to programs and projects that are over-budget and over reasonable development times; and the U.S. export control regime, namely ITAR, that posits barriers to international trade and partnerships that characterize much of space commercial activity.
- The basis for positive change to these constraints entails political leadership and vision, better management systems and organizational approaches to overcome budgetary and development time issues, and addressing workforce issues.
- There is a general misconception that space law, in particular international space law, is prohibitive to space commerce. This, in fact, is not the case. International space law simply places the state as the responsible party for any commercial activities that may take place under its legal jurisdiction.
- Space commerce is undergoing radical change due to private space activities that will lead to operational space ports to support private human spaceflight. The U.S. federal government, through the FAA-AST, is working to foster a positive regulatory environment that allows for private space activities to grow and prosper.
- Education and workforce issues where viewed as critical ones for space commerce development. Where will space commerce get the next generation technical workforce? High-percentages (more than 50% in some cases) of STEM graduate student in the U.S. are foreign nationals. Given this fact, there is a need to address export control concerns (e.g., ITAR) to better learn from foreign nationals (e.g., facilitate technology transfer). Other approaches could involve making better use of off-the-shelf technologies. Clearly, there is a need to emphasize a national commitment to STEM education at all levels.
- There is a strong consensus that the U.S., export control regime, ITAR, needs to be modified. ITAR has a direct effect on space commerce (see articles in this issue of the journal) and U.S. space and defense industrial base. ITAR also affects government agencies as much as those on the commercial side of space.
- The U.S. is at disadvantage in the global space business due to ITAR and the clear demarcations that are drawn in the U.S. between government space and commercial space. This latter issue limits the range of approaches that the U.S. could take to better foster space commercial development.
- The space environment is another key issue that affects space commerce. There is a mission cost, for example, to mitigate environmental dangers, like orbital debris proliferation. There are as well issues related to scarcity of resources and their efficient use, such as spectrum allocations. International standards are a key towards addressing many of the space environmental issues and challenges, and also necessary for space business to exercise due diligence in their safety and liability concerns and obligations.
- Space traffic management is another issue that requires some resolution as there is currently no

U.S. government policy on this or any set of international standards ("rules of the road") on this issue. This is of concern as apace is more crowed with more government and commercial players.

- Related to the space environmental issues is how to bets hare data (space situational awareness) between governments and with space commercial entities (see summary report herein on Space Situational Awareness workshop).

A summary of the synthesis discussions that took place at the workshop is provided in the table below. The synthesis discussion focused on what works in space commerce, what does not work, and what are the ways forward to better develop and foster space commerce.

What Works	Does Not Work	Ways Forward
Economy depends on space assets / critical economic enabler	Workforce issues	Develop space-based infrastructure (government lead)
Commercial satellite operations	Export controls (ITAR)	Reform ITAR
New space players / new operational modes and ways of doing business	Space manufacturing not a realistic business	Reduce cost of doing space business
Stable funding for space commence	Cost-plus contracting	Aim to get cost-plus contracting to no more than 15% of the way to do business / move more to fixed-pricing contracting model
Emergence of prizes to encourage innovation (see Addendum 1)	Space is branded with NASA and not with commercial activity	Non-traditional partnerships
More willingness for risk-taking (New Space)	Barriers to entry / economies of scale, politics as in ITAR	Leadership and vision on space commercial development
Concentrated private ownership / availability pf private monies	Low tolerance for risk (heritage space companies)	Delivering what is promised (budget and development time issues)
Space business ideas are more realistic (ROI issues) / better business planning and execution	Over regulation of space commerce (issue with Federal Acquisition Regulations)	Evolve legal regimes to meet challenges of space commerce

Addendum 1: Envisioning Space Commerce 2010 – 2030

Molly Macauley, Senior Fellow Resources for the Future

Perspectives

(1) "But for now, in spite of my usual optimism, I must say that I do not see any ready examples of stand-alone business successes in space. All must count on government orders to supplement their commercial business." John L. McLucas, *Space Commerce* (Boston, Harvard University Press), 1991, p. 213.

(2) "If we ever see cities on the moon or Mars – the kind of thing science fiction once promised so enticingly – I'm betting that the lion's share of credit will go not to NASA but to 21st century rocketeers." Glenn Reynolds, reviewing *Rocketeers* by Michael Belfiore in *The Wall Street Journal* 28-29 July 2007, p.11.

(3) "Given NASA's politicization, we should hope that the space industry evolves as aviation did – transitioning from ponderous government-run projects to mostly private-sector activities attuned to customer needs. That raises the question: Could entrepreneurs like Elon Musk and Jeff Bezos eventually put NASA out of business? Perhaps, but not for the next couple of decades – space has colossal economic barriers to entry. Given that NASA is sure to be around for a while, taxpayers should

insist the space agency be reconfigured to produce tangible benefits for all of us {earth observations and asteroid monitoring}. With any luck, private space enterprise will eventually find success and begin to exert competitive market pressures on the government space program." Gregg Easterbrook, "How NASA Screwed Up," *WIRED*, June 2007, pp. 154-155. {} added.

Space Commerce

Early Years (1960s–1980s)

- COMSAT raised its first capital by way of an oversubscribed $200 million stock issue, but failed to raise money for a direct to home satellite television service several years' later.
- RCA, Western Union, GE, AT&T, GTE, Hughes– all had relatively easy access to capital.
- Smaller companies (American Satellite, Direct Broadcast Satellite Corporation, Orion Satellite Corporation) had much more difficult access.
- Among early navigation suppliers, Qualcomm leased Ku-band transponders and used equity and funding from Goldman Sachs. Geostar required dedicated satellites and had more difficulty (Gerard O'Neill and Wheat First Securities provided initial funding).
- Orbital Sciences had private financing and venture capital; sold part of the company to Hercules (which provided the rocket motors); then went public in 1990.

Middle Years (1980s–2007)

- Deregulation here and internationally (telecommunications satellites).
- Mergers and acquisitions in aerospace (from 76 companies in 1980 to 5 in 2007).
- Venture capital.
- Return of prizes.
- Return of the industrialist.
- Emergence of space access as commodity.

Coming Decades (2007–2030)

- Relatively few mergers (1998 – attempted merger between Northrop Grumman and Lockheed Martin failed to obtain government approval).
- Acquisitions? (Increase in ownership share from 40% to 100% of Scaled Composites (builder of SpaceShipOne) by Northrop Grumman.
- Will capital markets, government policy, industrialist interest be favorable to space commerce?
- Will responsibility for and funding of Earth observations for environmental monitoring evolves to another agency?
- What will happen to federal funding of space activities with the arrival of financial challenges of entitlements programs (Social Security and Medicare)?

Government (Taxpayer) Financing and Space Commerce

Tax-Based Incentives

- Tax credits (most notably, the R&D tax credit).
- R&D expensing.
- Some previous legislative initiatives:

Space Tourism Promotion Act 2001 - H.R. 2443 - sought to stimulate the development of space tourism by means of guaranteed loans, tax credits, establishment of a "straightforward and predictable regulatory structure." However, US government space vehicles and the US modules of the space station could not be used by anyone except officially permitted visitors. Sponsored by Rep. Nick Lampson (D-TX).

Zero Gravity Zero Tax Bill 2003- H.R. 914 – would exclude space-related income from gross income for calculating income taxes for 10 years, except for income from space-based telecommunications, remote-sensing, and space launch companies currently in business. Would provide $100 million in tax credits for investments in new space enterprises. No capital gains tax on the sale of the stock for a period of

10 years. Sponsored by Rep. Dana Rohrabacher (R-CA).

Invest in Space Now Act 2003 - H.R. 2177 – would provide tax credits to investments in qualified new space launch vehicles. The sliding scale would drop from 50% of the value of the stock in 2002 to zero after 2010. Sponsored by Rep. Ken Calvert (R-CA) and Rep. Solomon Ortiz (TX).

Spaceport Equality Act 2003 - H.R.644 – would allow commercial spaceports, like airports, to be financed with bonds exempt from federal tax on their interest payments (much like tax-free municipal bonds). Sponsored by Rep. Dave Weldon (R-FL.).

Competitive Bidding Processes

- Grants and contracts (prize is a commitment to procure).
- Prizes (typically *ex ante*, or "inducement prizes" as distinguished from *ex post* awards).

Use of government-owned, government-operated or contractor-operated laboratories or other research facilities

State or local government concessions (such as financing spaceports)

Other forms of government involvement indirectly (but perhaps significantly) affecting financing

- Oversight of mergers and acquisitions.
- Intellectual property protection.
- Legislative and regulatory provisions.
- National security concerns (such as those addressed by International Traffic in Arms Regulations- ITAR).

Industrialists, Other Champions, and Private Capital

Industrialists

Esther Dyson, an investor in Constellation Services, ICON Aircraft, Space Adventures, XCOR, and Zero-Gravity Corporation, writing in *Space News*, 14 May 2007: "an illustrious crew of pioneers:"

- **Elon Musk**, founder and CEO of Space Exploration Technologies Corp and founder of PayPal.
- **Vern Raburn**, CEO of Eclipse Aviation (which produces very light jets) and formerly at Microsoft, Symantec, and Lotus.
- **Jeff Bezos**, founder of Blue Origin and still at Amazon, which he also founded.
- **Jeff Greason**, founder of XCOR and formerly with Intel.
- **Ed Iacobucci**, president and CEO of air taxi operator Dayjet Corporation and founder of Citrix.

She goes on to comment in *Space News*:

"While investors are starting to take note, they remain nervous. The challenge for these start-ups right now is that investors want to invest in the third round. They want someone else to take the risks so they can come in when the price has been beaten down and the risks have been overcome. …This is indeed what happened with FedEx. As venture capitalist Rick Stowe recalls: 'The third-round FedEx investors were most – but not all – of the first- and second-round investors. The only new ones were (lawyer) Bill Hewitt and management other than (founder) Fred (Smith). The third round ($3.9 million for two-thirds of the company) was one of history's best deals, but we couldn't sell it to anyone who wasn't already mired in the company. The upside was a little murky at the time!"

Examples not on Dyson's list:

Paul Allen, cofounder of Microsoft and investor in Scaled Composites (builder of SpaceShipOne and winner of the $10 million Ansari X Prize in 2004.

- **Sir Richard Branson**, founder and owner of over 350 companies including Virgin Records and Virgin Atlantic Airways and founder of Virgin Galactic, which plans to license the technology behind SpaceShipOne.
- **Robert Bigelow**, real estate developer and developer of the Genesis inflatable space station structures.
-

***Space News*, 25 June 2007**

"In 2006 approximately 234,000 angel investors in the US invested $25.6 billion in 51,000 deals across all industries. Total seed-stage angel funding for new space ventures, however, amounted to at most $10 million spread over approximately 10 deals, which were sourced entirely from individual investors… The disparity in these figures clearly demonstrates both the absence of an educated and space-savvy angel investor community, as well as a pressing need for companies to show potential investors better business models and more experienced management teams."

"U.S. venture capital investment in 2006, in contrast, reached $25.8 billion, and was spread over slightly more than 3,000 deals with no known investments in core space infrastructure startups."

"Traditional definitions of 'New Space' and 'alt.space' tend to emphasize high-risk Earth-to-space and space-to-space applications, such as space tourism, rocket launchers, on-orbit refueling facilities, on-orbit servicing and space solar power. These definitions ignore the wider expanse of lower-risk space-to-Earth and Earth-to-Earth startups such as telecommunications, Earth observation, navigation and mapping, telemedicine, space-themed attractions, and many other mainstream applications. …superior investment prospects due to track record of *successful exits* that are well understood by the mainstream investor community around the globe."

Note on the Jargon

The "technology startup financing pipeline" includes: (1) "pre-seed" and "seed-stage," early stage where angel investors play a role; and (2) "venture" stage, a somewhat later stage– with slightly more certain *exit* strategies.

Background Information

Examples of inducement prizes sponsored by private sector:

- Auto races (achievements in speed, durability, aesthetics, and economy) – Publishers, industrialists.
- Aviation (distance, speed, endurance) – Publishers, industrialists.
- *Ansari X-Prize* (26 teams, 7 different countries, estimated $100 million of private R&D spending for $10 million prize).
- *Archon X Prize* for Genomics ($10 M to map 100 human genomes in 10 days to advance personalized preventative medicine) – X-Prize Foundation.
- *Virgin Earth Challenge* ($ 25 M to remove 1 billion metric tons of carbon for 10 years; $5 M at start of removal and $20 M at end of 10 years; financed by Richard Branson).
- *The Grainger Challenge Prize* (($1.0 M, $200,000, and $100,000 for design and creation of a point-of-use water treatment system for developing countries) – The National Academy of Engineering and the Grainger Foundation.

Examples of inducement prizes sponsored by government sector or government and private sectors:

- Chronometers (longitude)– Royal Navy, London merchants, and commercial ships' captains (three prizes for varying degrees of accuracy; first place about equal to US $3.1 million in today's dollars).
- Alkali– French Academy of Sciences.
- Canning– Napoleon's Society for the Encouragement of Industry.
- *Super-Efficient Refrigerator Program* – sponsored by US Environmental Protection Agency and 25 electric utilities (winner (Whirlpool) never received full allotment of prize money).
- *The Automotive X Prize (AXP)* (build a 100 mile per gallon vehicle – funding not yet attained as of August 2007)– X Prize Foundation, other foundations, nongovernmental organizations, government agencies.
- DARPA Grand Challenge.
- *DDR&E Prize* (various amounts to solve problems of military interest; current offering is

$1 M, $.5 M, and $.25 M for a wearable poser system)– The 2007 NDAA Defense bill.

- NASA Centennial Challenges

Challenge Date	Challenge Name	Purse	Allied Organization
Oct 13-21, 2007	2007 Beam Power Challenge	$500K	The Spaceward Foundation *(non-NASA link)*
Oct 13-21, 2007	2007 Tether Challenge	$500K	The Spaceward Foundation *(non-NASA link)*
Oct 26-28, 2007	Lunar Lander Challenge	$2M	The X PRIZE Foundation *(non-NASA link)*
2008 (Date TBD)	Astronaut Glove Challenge	$400K	Volanz Aerospace Inc./Spaceflight America *(non-NASA link)*
2008 (Date TBD)	2008 Regolith Excavation Challenge	$750K	California Space Education & Workforce Institute (CSEWI) *(non-NASA link)*
2008 (Date TBD)	2008 Personal Air Vehicle Challenge	$300K	Comparative Aircraft Flight Efficiency (CAFE) Foundation *(non-NASA link)*
Expires Jun 1, 2008	Moon Regolith Oxygen Extraction (Moon ROx) Challenge	$1M	California Space Education & Workforce Institute (CSEWI) *(non-NASA link)*

Abbreviations:
CAFE = Comparative Aircraft Flight Efficiency Foundation
CSEWI = California Space Education and Workforce Institute
Moon ROx = Moon Regolith Oxygen
Source: centennialchallenges.nasa.gov (accessed July 2007)

Challenge Date	Challenge Name	Winner/Purse	Allied Organization
Aug 4-11, 2007	2007 Personal Air Vehicle Challenge	Vance Turner / $100K Vantage Prize Dave and Diane Anders / $50K Noise Prize John Rehn / $25K Handling Qualities Vance Turner / $25K Shortest Runway Prize Vance Turner / $25K Efficiency Prize Dave and Diane Anders / $15K Top Speed First Prize Vance Turner / $10K Top Speed Second Prize	Comparative Aircraft Flight Efficiency (CAFE) Foundation *(non-NASA link)*
May 11-12, 2007	2007 Regolith Excavation Challenge	None/$250K	California Space Education & Workforce Institute (CSEWI) *(non-NASA link)*
May 2-3, 2007	2007 Astronaut Glove Challenge	Peter Homer/$200K	Volanz Aerospace Inc./Spaceflight America *(non-NASA link)*
Oct 20-21, 2006	2006 Beam Power Challenge	None/$200K	The Spaceward Foundation
Oct 20-21, 2006	2006 Tether Challenge	None/$200K	The Spaceward Foundation
Oct 20-21, 2006	2006 Lunar Lander Challenge	None/$2M	The X PRIZE Foundation
Oct 21-23, 2005	2005 Beam Power Challenge	None/$50K	The Spaceward Foundation
Oct 21-23, 2005	2005 Tether Challenge	None/$50K	The Spaceward Foundation

Source: centennialchallenges.nasa.gov (accessed July 2007)

Comparing Government-funded Prizes, Contracts, and Grant

Pros	Risk borne by innovator not taxpayer Subsidizes final output or product not inputs Lower administrative costs Leverage non-financial incentives (prestige, media spotlight) Lower barriers to entry for small innovative companies Information gleaned about technology state-of-the-art in event of non-winner	Possibly more appropriate for basic research (risk shared with researcher who must "publish or perish"; knowledge gained from research may be quickly and widely shared) Possibly more appropriate for very high-cost projects Pre-proposal and other interim competition/review ("prize-like" elements) can reduce principal-agent information asymmetry May reduce duplicative research
Cons	Difficult to "size" the prize – depends on 'value' to nation Up-front liquidity constraint Less suited if innovators cannot bear all the risk (or very high-cost projects) May lead to excessive duplication of effort during competition May reward "first past the post" prioritizing speed rather than quality	Government susceptible to cost estimation and cost-overrun problems related to principal-agent situation High entry barriers Less appropriate for applied technology research Susceptible to Congressional earmarking
• Issues with government sponsorship: Likely to require Congressional appropriation; multi-year funding; need to convince competitors that government will not renege; if no one wins, is agency budget reduced or can funding be reprogrammed; desirable to have information on benefits to taxpayer of the technological advance in order to "size" the prize. • Some researchers suggest that the contestants themselves propose the size of the prize, as they are better informed about costs and the likelihood of success- Yeon-Koo Che and Ian Gale, "Optimal Design of Research Contests," *American Economic Review* 93(3): 646-671 (2003). • Sources: Based on Richard G. Newell and Nathan E. Wilson, "Technology Prizes for Climate Change Mitigation," Resources for the Future Discussion Paper 05-33 June 2005 (table 1); Molly K. Macauley, "Advantages and Disadvantages of Prizes in a Portfolio of Financial Incentives for Space Activities," *Space Policy* 21(1): 29-39 (2005)		

Towards a Space Commerce Future with Prizes?

- Could move beyond NASA to include NSF, NIST, DOE, etc, if broader than space influence but would then face complexity of oversight from multiple Congressional committees
- The 2004 Aldridge Commission's report ("A Journey to Inspire, Innovate, and Discover") outlines one of the possible ways the U.S. could establish a prize for lunar settlement:
- "...the Commission suggests that… as an example of a particularly challenging prize concept, $100 million to $1 billion could be offered to the first organization to place humans on the Moon and sustain them for a fixed period before they return to Earth."

Space Based Solar Power Workshop

Eisenhower Center for Space and Defense Studies
National Security Space Office

Breckenridge, Colorado, September 2007

Preventing resource conflicts in the face of increasing global populations and demands in the 21st century is a high priority for the United States (U.S.) Department of Defense (DOD). All solution options to these challenges should be explored, including opportunities from space.

In March 2007, the National Security Space Office's (NSSO) Advanced Concepts Office presented the idea of space based solar power (SBSP) as a potential grand opportunity to address not only energy security, but environmental, economic, intellectual, and space security as well. First proposed in the late 1960s, the concept was last explored in NASA's 1997 "Fresh Look" Study. In the decade since this last study, advances in technology and new challenges to security have warranted a current exploration of the strategic implications of SBSP. For these reasons, NSSO sponsored a no cost Phase 0 Architecture Feasibility Study of SBSP during the spring and summer of 2007.

Unlike traditional contracted architecture studies, the report (executive summary is shown below, see http://www.nss.org/settlement/ssp/library/nsso.htm) was compiled through a collaborative approach that relied upon voluntary internet discussions by more than 170 academic, scientific, technical, legal, and business experts around the world. These discussions were highlighted in a workshop sponsored by NSSO and the Eisenhower Center for Space and Defense Studies.

The results of the workshop led to the development of an interim assessment that contains significant initial findings and recommendations, which provide pause and consideration for national and international policy-makers, business leaders, and citizens alike. It appears that technological challenges are closing rapidly and the business case for creating SBSP is improving with each passing year. Still absent, however, is an appropriate catalyst to stimulate the various interested parties toward actually developing SBSP capability.

Executive Summary

Consistent with the U.S. National Security Strategy, energy and environmental security are not just problems for America; they are critical challenges for the entire world. Expanding human populations and declining natural resources are potential sources of local and strategic conflict in the 21st Century, and many see energy scarcity as the foremost threat to national security. Conflict prevention is of particular interest to security-providing institutions such as the U.S. DOD, which has elevated energy and environmental security as priority issues with a mandate to proactively find and create solutions that ensure U.S. and partner strategic security.

The magnitude of the looming energy and environmental problems is significant enough to warrant consideration of all options, to include revisiting the SBSP concept that was first invented in the U.S. almost 40 years ago. The basic idea is very straightforward: place very large solar arrays into continuously and intensely sunlit Earth orbit (1,366 watts/m^2), collect gigawatts of electrical energy, electromagnetically beam it to Earth, and receive it on the surface for use either as base-load power via direct connection to the existing electrical grid, conversion into manufactured synthetic hydrocarbon fuels, or as low-intensity broadcast power beamed directly to consumers. A single kilometer-wide band of geosynchronous Earth orbit experiences enough solar flux in one year to nearly equal the amount

of energy contained within all known recoverable conventional oil reserves on Earth today. This amount of energy indicates that there is enormous potential for energy security, economic development, improved environmental stewardship, advancement of general spacefaring activities, and overall national security for those states that construct and possess SBSP capability.

NASA and the U.S. Department of Energy have collectively spent $80 million over the last three decades in sporadic efforts studying this concept (by comparison, the U.S. Government has spent approximately $21 billion over the last 50 years continuously pursuing nuclear fusion). The first major effort occurred in the 1970s where scientific feasibility of the concept was established and a reference 5 gigawatt design was proposed. Unfortunately 1970s architecture and technology levels could not support an economic case for development relative to other lower-cost energy alternatives on the market. In 1995-1997 NASA initiated a "Fresh Look" Study to re-examine the concept relative to modern technological capabilities. The report (validated by the National Research Council) indicated that technology vectors to satisfy SBSP development were converging quickly and provided recommended development focus areas, but for various reasons that again included the relatively lower cost of other energies, policy-makers elected not to pursue a development effort.

The post-9/11 situation has changed that calculus considerably. Oil prices have jumped from $15 per barrel to more than $100 per barrel in less than a decade. In addition to the emergence of global concerns over climate change, American and allied energy source security is now under threat from actors that seek to destabilize or control global energy markets as well as increased energy demand competition by emerging global economies. Our National Security Strategy recognizes that many states are too dependent on foreign oil, often imported from unstable portions of the world, and seeks to remedy the problem by accelerating the deployment of clean technologies to enhance energy security, reduce poverty, and reduce pollution in a way that will ignite an era of global growth through free markets and free trade. Senior U.S. leaders need solutions with strategic impact that can be delivered in a relevant period of time.

In March of 2007, the NSSO Advanced Concepts Office presented this idea to the agency Director. Recognizing the potential for this concept to influence not only energy, but also space, economic, environmental, and national security, the Director instructed the Advanced Concepts Office to quickly collect as much information as possible on the feasibility of this concept. Without the time or funds to contract for a traditional architecture study, the Office turned to an innovative solution: the creation of an open source, internet-based, interactive collaboration forum aimed at gathering the world's SBSP experts into one particular cyberspace. Discussion grew immediately and exponentially, such that there are now 170 active contributors as of the release of this report (October 2007); this study approach was an unequivocal success and should serve as a model for DOD when considering other study topics.

Study leaders organized discussions into five groups- (1) a common plenary session; (2) science and technology; (3) law and policy; (4) infrastructure and logistics; and (5) the business case- and challenged the group to answer one fundamental question: Can the U.S. and partners enable the development and deployment of a SBSP system within the first half of the 21st Century such that if constructed could provide affordable, clean, safe, reliable, sustainable, and expandable energy for its consumers? Discussion results were summarized and presented at a workshop in Colorado during September 2007 hosted by the U.S. Air Force Academy Eisenhower Center for Space and Defense Studies.

Over the course of the study several overarching themes emerged:

- The SBSP Study Group concluded that space-based solar power does present a strategic opportunity that could significantly advance

U.S. and partner security, capability, and freedom of action, and merits significant further attention on the part of both the U.S. Government and the private sector.

- The SBSP Study Group concluded that while significant technical challenges remain, space-based solar power is more technically executable than ever before, and current technological vectors promise to further improve its viability. A government-led proof-of-concept demonstration could serve to catalyze commercial sector development.
- The SBSP Study Group concluded that SBSP requires a coordinated national program with high-level leadership and resourcing commensurate with its promise, at least on the level of fusion energy research or International Space Station construction and operations.
- The SBSP Study Group concluded that should the U.S. begin a coordinated national program to develop SBSP, it should expect to find that broad interest in SBSP exists outside of the U.S. Government, ranging from aerospace and energy industries, to foreign governments, such as Japan, the European Union, Canada, India, China, Russia, and others, to many individual citizens who are increasingly concerned about the preservation of energy security and environmental quality. While the best chances for development are likely to occur with U.S. Government support, it is entirely possible that SBSP development may be independently pursued elsewhere without U.S. leadership.
- Certain key questions about SBSP were not answerable with adequate precision within the time and resource limitations of this interim study, and form the agenda for future action. The fundamental tasks/questions are: identification of clear targets for economic viability in markets of interest; identification of technical development goals and a roadmap for retiring risk; selection of the best design trades; and full design and deployment of a meaningful demonstrator.

The study group determined four overarching recommendations:

- **Recommendation #1:** The study group recommends that the U.S. Government should organize effectively to allow for the development of SBSP and conclude analyses to resolve remaining unknowns.
- **Recommendation #2:** The study group recommends that the U.S. Government should retire a major portion of the technical risk for business development.
- **Recommendation #3:** The study group recommends that the U.S. Government should create a facilitating policy, regulatory, and legal environment for the development of SBSP.
- **Recommendation #4:** The study group recommends that the U.S. Government should become an early demonstrator/adopter/ customer of SBSP and incentivize its development.

Several major challenges will need to be overcome to make SBSP a reality, including the creation of low-cost space access and a supporting infrastructure system on Earth and in space. Solving these space access and operations challenges for SBSP will in turn also open space for a host of other activities that include space tourism, manufacturing, lunar or asteroid resource utilization, and eventually settlement to extend the human race.

Because DOD would not want to own SBSP satellites, but rather just purchase the delivered energy as it currently does via traditional terrestrial utilities, a repeated review finding is that the commercial sector will need the government to accomplish three major tasks to catalyze SBSP development. The first is to retire a major portion of the early technical risks. This can be accomplished via an incremental research and development program that culminates with a space-borne, proof-of-concept demonstration in the next decade. A spiral development proposal to field a 10 megawatt continuous pilot plant en route to gigawatts-class systems is proposed. The second challenge is to facilitate the policy, regulatory, legal, and organizational instruments that will be necessary to create the partnerships and relationships (commercial-commercial,

government-commercial, and government-government) needed for this concept to succeed. The final government contribution is to become a direct early adopter and to incentivize other early adopters much as is accomplished on a regular basis with other renewable energy systems coming on-line today.

For the DOD specifically, beamed energy from space in quantities greater than 5 megawatts electrical has the potential to be a disruptive game changer on the battlefield. SBSP and its enabling wireless power transmission technology could facilitate extremely flexible "energy on demand" for combat units and installations across an entire theater, while significantly reducing dependence on vulnerable over-land fuel deliveries. SBSP could also enable entirely new force structures and capabilities, such as ultra long-endurance airborne or terrestrial surveillance or combat systems to include the individual soldier himself. More routinely, SBSP could provide the ability to deliver rapid and sustainable humanitarian energy to a disaster area or to a local population undergoing state-building activities. SBSP could also facilitate base "islanding" such that each installation has the ability to operate independent of vulnerable ground-based energy delivery infrastructures. In addition to helping American and allied defense establishments remain relevant over the entire 21st Century through more secure supply lines; perhaps, the greatest military benefit of SBSP is to lessen the chances of conflict due to energy scarcity by providing access to a strategically secure energy supply.

Despite this early interim review success, there are still many more questions that must be answered before a full-scale commercial development decision can be made. It is proposed that in the spirit of the original collaborative SBSP Study Group charter, that this interim report becomes a living document to collect, summarize, and recommend on the evolution of SBSP. The positive indicators observed to surround SBSP by this review team suggest that it would be in the U.S. Government's and the nation's interest to sponsor an immediate proof-of-concept demonstration project and a formally funded, follow-on architecture study conducted in full collaboration with industry and willing international partners. The purpose of a follow-on study will be to definitively, rather than speculatively, answer the question of whether all of the barriers to SBSP development can be retired within the next four decades and to create an actionable business case and construction effort roadmap that will lead to the installation of utility-grade SBSP electric power plants. Considering the development timescales that are involved, and the exponential growth of population and resource pressures within that same strategic period, it is imperative that this work for "drilling up" versus "drilling down" for energy security begins immediately.

Improving Our Vision II: Building Transparency and Cooperation

Workshop on Space Situational Awareness Data Sharing

Eisenhower Center for Space and Defense Studies
World Security Institute's Center for Defense Information
Secure World Foundation

London, United Kingdom, October 2007

This was the second workshop to bring together a range of stakeholders to discuss global needs and capabilities for Space Situational Awareness (SSA). The first workshop was held in September 2006 in Colorado Springs, Colorado. This 2006 workshop was sponsored by the Eisenhower Center for Space and Defense Studies and the World Security Institute's Center for Defense Information. The 2006 workshop report can be found at the following internet site: http://www.cdi.org/PDFs/SSAConference_screen.pdf.

The goal of the SSA workshops are to bring together the full range of stakeholders interested in SSA– from practitioners to users of data, representatives of industry, the military, the scientific community, international organizations, and the satellite-tracking community– to discuss how needs are changing, what improvements in capabilities can be achieved in the near- to mid-term future, and how various stakeholder communities might better interact to draw on each other's strengths.

The specific goal of the 2007 SSA workshop was to explore, and potentially forward, areas of possible transatlantic cooperation and partnership to improve SSA data sharing. Space surveillance, estimating orbits of satellites in near Earth space for varied purposes, including collaborative operations, debris management, and more effective communication, environmental monitoring, and data gathering operations were emphasized. In addition, the workshop looked at how informal or formal international regimes might help underpin or forward improved SSA data sharing. More than sixty technical experts, management principals from industry and government, and respected policy, law, and international relations luminaries participated.

Participation included, among others, policy makers and technologists from many countries and international organizations, including: Germany, Norway, Sweden, United Kingdom, France, Canada, the United States, the European Space Agency, and the UN Committee for the Peaceful Uses of Outer Space. While many of the presentations were primarily informational, areas of consensus during discussions appear to have emerged around the potential for building informal processes for international data exchange that could improve SSA. In addition, all participants expressed their dedication to ensuring robust SSA to safeguard current and future space operations. A full conference report is expected to be published in 2008, and there is interest in a follow-on workshop in 2008.

The conference was conducted under a modified Chatham House Rule, in which prepared statements and presentations are attributable to their authors, but comments and opinions thereafter are not. Presentations are available by request at a Google group site http://groups.google.com/group/ssa-workshop-series?hl=en.

A summary of the discussions that took place at the workshop is provided below.

- Phase II of the Commercial and Foreign Entities (CFE) program was stressed that will include SSA data sharing on maneuver notification, debris mitigation, end of life management, and respect of protected regions.
- French space policy was discussed that emphasizes freedom of access and security of

satellites, while accounting for legitimate defense interests. This emphasis serves as the strategic guidelines for European space collaboration that have been applied for Galileo and the Global Monitoring for Environment and Security (GMES). The GRAVES space surveillance radar was also described. It is operated by the French Air Force.

- It was stated that Germany still relies on the United States Air Force (USAF) SSA TLE data. At the same time, Germany's FGAN and TIRA space surveillance sensors were described, and it was suggested that the European Space Operations Center (ESOC) located in Germany, which provides satellite control for the European Space Agency (ESA), serve as a European SSA center.
- The Globus II space surveillance radar, controlled by the Norwegian Defense Research Establishment, was offered for SSA collaboration and sensor calibration.
- A number of European workshop participants declared that Europe must have independent SSA. It was recognized that SSA data provided by the U.S. is not exhaustive enough or responsive enough, yet concomitantly Europe could not do the job alone. Many European participants were also adamant of the European need to validate U.S. information (i.e., Europe must independently characterize sources of data), questioning the credibility of orbit information provided by the U.S.
- The resulting actions to date aimed at an independent SSA capability in Europe include: ESA forming a civil-military space forum and an SSA user group; and European Cooperation for Space Standardization (ECSS) conducting SSA technology development studies. Europe aims to develop SSA architecture for tracking, imaging, and space weather. The ESA Management Council will undertake a data sharing policy. It was noted that European SSA is an essential element of European commerce and society and does not require a business case.
- Participants stated that there are clear and present dangers to space activities that necessitate more robust and enhanced SSA data sharing. The principal issue is how to make space activities safer and more secure, given that weaponization of space was viewed as a potential obstacle to SSA data sharing.
- Analogies were drawn with rules of the road (codes of conduct) at sea and open skies, and how such rules fail to apply in space. The key insight was that rules or codes must be technically based and that the debate should not be conducted only from a legal point of view as is the tendency today.
- It was stressed that international standards serve as one of the best ways for more robust and enhanced SSA international collaboration. Of note, is that there is no world wide forum to distill top-level SSA data requirements. Although there is uniform agreement on the need for SSA data sharing, requirements have not been consolidated.
- It was suggested that NATO serve as a vehicle for combined space capability on SSA.
- Ways in which to better integrate orbital debris and space weather data into SSA data sharing were discussed. Some ideas included: real time space weather feeds; and debris observation campaigns (e.g., each observer provides his data to the other observers, who could independently combine the information).
- Space surveillance capability, a range of sensors, a space catalog, world wide coverage, ownership of a class of data, services like collision avoidance, and operational capability and experience were all viewed as essential elements of a nation's space presence.
- The USAF TLE process was criticized with the requisite need of better collaborative collision avoidance to be put in place.
- A number of potential models for SSA data sharing were discussed. This includes: broad data exchange approaches; maritime data sharing in NATO; advancing USAF approaches; "neighborhood watch" for space threats as part of a voluntary code of conduct; space traffic management; and a space safety organization.
- UNCOPUOS was seen as NOT the right place for SSA initiatives.

- Insurance of space activities were viewed as potentially driving greater diligence with collision avoidance, since insurance underwriters recognize the difference between good and bad space operators.

Ambassador Roger Harrison and Dr. Eligar Sadeh
Eisenhower Center for Space and Defense Studies